Instruction Manual

FLUKE®

Instruction Manual

This manual documents the Model 2190A and its assemblies at the revision levels shown in appendix 7A. If your instrument contains assemblies with different revision letters, it will be necessary for you to either update or backdate this manual. Refer to the supplemental change/errata sheet for newer assemblies, or to the backdating sheet in appendix 7A for older assemblies.

KENT C/C

Model

2190A

Digital Thermometer

P/N 489229

June 1978

LIMITED WARRANTY

The JOHN FLUKE MFG. CO., INC., warrants each instrument it manufactures to be free from defects in material and workmanship under normal use and service for the period of one year from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, disposable batteries (rechargeable type batteries are warranted for 90 days), or any product or parts which have been subject to misuse, neglect, accident or abnormal conditions of operations.

In the event of failure of a product covered by this warranty, John Fluke Mfg. Co., Inc., will repair and calibrate an instrument returned to an authorized Service Facility within one year of the original purchase; provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within one year of the original purchase, said repairs or replacement will be made without charge. If the fault has been caused by misuse, neglect, accident or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS SHALL BE LIMITED TO A PERIOD OF TWELVE MONTHS FROM THE DATE OF PURCHASE. THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. JOHN FLUKE MFG. CO., INC. SHALL NOT BE LIABLE FOR ANY SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT OR OTHERWISE.

NOTE: Some states do not allow limitations on how long an implied warranty lasts, or the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusion may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

If any fault develops, the following steps should be taken:

1. Notify the John Fluke Mfg. Co., Inc. or nearest Service facility, giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument, transportation prepaid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT

All shipments of John Fluke Mfg. Co., Inc., instruments should be made via United Parcel Service or "Best Way*" prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid and of adequate size. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER

The instrument should be thoroughly inspected immediately upon original delivery to purchaser. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. (To obtain a quotation to repair shipment damage, contact the nearest Fluke Technical Center.) Final claim and negotiations with the carrier must be completed by the customer.

The John Fluke Mfg. Co., Inc. will be happy to answer all application or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO., INC., P.O. Box 43210, MOUNTLAKE TERRACE, WASHINGTON 98043, Atten: Sales Dept. For European Customers: FLUKE (Nederland) B.V., Zevenheuvelenweg 53, Tilburg, The Netherlands.

* For European customers, Air Freight prepaid.

John Fluke Mfg. Co., Inc. • P.O. Box 43210 • Mountlake Terrace, Washington 98043

Rev. 12/77

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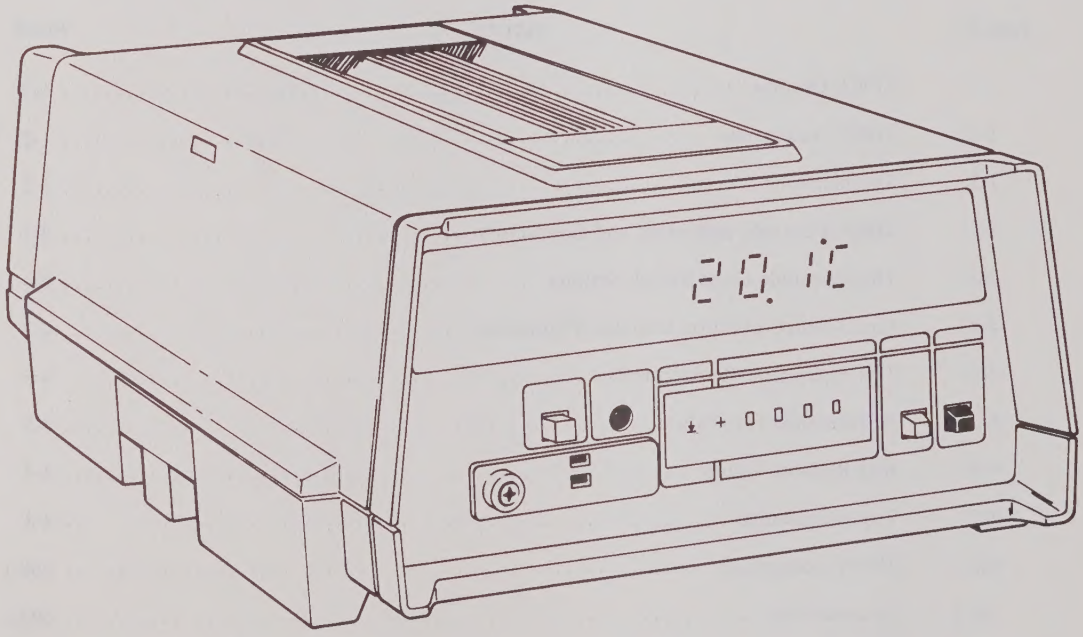


2190A Digital Thermometer

Section 1
Introduction & Specifications

1-1. INTRODUCTION

1-2. The Model 2190A Digital Thermometer is a portable, stackable, five digit, thermocouple thermometer capable of temperature measurements over a range of –242°C to +2471°C (–405°F to +4480°F) with a resolution of 0.1°. The instrument features automatic reference-junction compensation, eliminating the requirement for an ice bath reference junction; front panel switch selection of Fahrenheit or Celsius readings; switch selectable thermocouple inputs (choice of seven types); switch selectable input line voltage; dual-slope measurement techniques; and digital linearization of the thermocouple inputs.

1-3. The instrument display has six high-intensity, seven segment LEDs, and leading zero suppression. Five of the LEDs are used to display numeric data, including a minus sign for negative temperature readings. The remaining LED displays the selected temperature scale character (°F or °C). The symbol "O.C." is displayed when an open-thermocouple is detected at the thermocouple input terminals.

1-4. Screw-type input connectors, on a removable module are provided for attaching the selected thermocouple. The terminals are an integral part of an isothermal block which serves as a portion of the reference-junction compensation circuit. This circuit removes the need for an ice bath reference junction (0°C or 32°F) since it provides the electrical equivalent automatically.

1-5. Selection of the temperature scale for display is made with a front panel pushbutton. The scale selected, Celsius or Fahrenheit, is displayed as either the character °C or °F as the last character in the temperature reading. A scale change can be made at any time, and has no effect on calibration of the instrument.

1-6. The measurement range of the 2190A is determined by the type of thermocouple used as the input device. The microcomputer uses one program for thermocouples of the J, K, T, C, and R types and a different program for J, K, E, R and S types. The version required must be specified when ordering the instrument. Choice of the thermocouple type is accomplished by selecting the applicable switch position on the removable input module using the table printed beside the switch on the pcb. Recalibration is not required if the thermocouple type is changed.

NOTE

The letter C is not an ISA/ANSI thermocouple designation. C is used for convenience only to represent Tungsten-5% Rhenium versus Tungsten-26% Rhenium alloy.

1-7. The instrument is in a TemPak case (also referred to as Portable Test Instrument or PTI case). This lightweight durable plastic case makes the instrument truly portable when used with the Y2003 or Y2009 external power sources and can be stacked for one handle portability.

1-8. Options and accessories available for the 2190A are listed in Tables 1-1 and 1-2 respectively. Detailed information concerning each item listed is given in Section 6 of this manual, Option and Accessory Information.

1-9. Four input line voltages are available for switch selection. Selection may be made for 100, 120, 220, or 240 volts ±10% as required to meet local conditions. Frequency may vary between 50 to 440 Hertz for all voltage selections. Refer to Section 4 of this manual on how to change the selected input line voltage. The instrument will also operate with an external input of 12V dc.

1-10. SPECIFICATIONS

1-11. Specifications for the 2190A thermometer are given in Table 1-3.

Table 1-1. 2190A Options

OPTION	DESCRIPTION
21X0–002	Output Option
21X0–006	Limits Option

Table 1-2. 2190A Accessories

ACCESSORIES	DESCRIPTION
Y2001	Multipoint Selector, Thermocouple
Y2002	Alarms Output
Y2003	Calibrator, Thermocouple Indicator
Y2009	Battery Pack, 12V Rechargeable
Y2010	Rack Panel PTI, single, A size (for Y2001)
Y2011	Rack Panel PTI, double, A size (for Y2001)
Y2012	Rack Panel PTI, single, B size (for Y2003 and Y2009)
Y2013	Rack Panel PTI, double, B size (for Y2003 and Y2009)
Y2014	Rack Panel PTI, single, C size (for 2190A, Y2002 and Y2023)
Y2015	Rack Panel PTI, double, C size (for 2190A, Y2002 and Y2023)
Y2018	Panel Mount PTI-DIN, A size (for Y2001)
Y2019	Panel Mount PTI-DIN, B size (for Y2003 and Y2009)
Y2020	Panel Mount PTI-DIN, C size (for 2190A, Y2002 and Y2023)
Y2022	Divider, Thermometer Calibrator
Y2023	Accessory Case
Y2024	Power Cord, 3-way
P20J	J-Type Thermocouple Probe
P20K	K-Type Thermocouple Probe
P20T	T-Type Thermocouple Probe
P20E	E-Type Thermocouple Probe

Table 1-3. Specifications

2190A Digital Thermometer

Thermocouple Types: Choice of seven. Five types selectable via a rotary switch located on the input assembly. Either J, K, E, R, and S or J, K, T, C*, and R.
Display: °F or °C, switch-selectable, 7-segment LED.s 1.1 cm high.
Resolution: 0.1°.
Measurement Method: Dual slope integration, under micro-computer control. 100 ms integration period, three readings per second.
Linearization Technique: Computer algorithm, 4th order curve fit.
Warm-Up to Rated Accuracy: 20 minutes.

Table 1-3. Specifications (cont)

Reference Junction Compensation: 0.005° per degree from 25°C.
Temperature Coefficient: ±15 ppm/°C from 25°C.
Stability: ±175 ppm in 90 days, 200 ppm per year.
Common Mode Rejection: ⩾160 dB at 50, 60, and 400 Hz ±0.1%, with 100Ω unbalance at input.
Common Mode Voltage: 350V dc or 250V ac rms max.
Normal Mode Rejection: ⩾90 dB at 50, 60, and 400 Hz ±0.1%.
Zero Drift: Automatic zero correction.
Input Connection: Two wires, on screw terminal isothermal block.
Input Impedance: 1000 MΩ at dc.
Max. Source Impedance: 2 kΩ.
Power: 12V dc or 100, 200 or 240V ac ±10%, selectable, 50 to 400 Hz; 8W typical.
Size and Weight: Style C case, 2.1 kg (4 lbs. 9 oz.), typical.
Overrange (Overload) Detection: The thermometer display flashes either positive full scale or negative full scale depending on the polarity of the overload (voltage).
Open Circuit Detection: A source impedance of 3 kΩ or more causes the thermometer to display a flashing "O.C.". An internal switch allows a user to simulate a + overload or – overload which can be used to control limits or alarms for failsafe control.

** Type "C" is not an ANSI/ISA approved designation. It is used to designate Tungsten-5% Rhenium vs. Tungsten-26% Rhenium.*

2190A Total Instrument Accuracy Specifications

Thermocouples		Maximum Error					
		±Degrees C			±Degrees F		
Type	Applicable Portion Of Temp. Range, °C	At Cal.	90 Dys 20°C to 30°C	1 Yr 15°C to 35°C	At Cal.	90 Dys 68°F to 86°F	1 Yr 59°F to 95°F
J	–128 to 0	0.18	0.19	0.21	0.20	0.23	0.26
	0 to 900	0.18	0.31	0.36	0.20	0.47	0.58
K	–132 to 0	0.18	0.19	0.21	0.30	0.33	0.37
	0 to 1350	0.18	0.39	0.47	0.30	0.72	0.87
T	–243 to 0	0.18	0.20	0.22	0.30	0.35	0.39
	0 to 400	0.18	0.22	0.25	0.30	0.41	0.46
E	–252 to 0	0.18	0.20	0.22	0.30	0.35	0.40
	0 to 1000	0.18	0.33	0.39	0.30	0.61	0.72
R	0 to 1708	0.31	0.59	0.70	0.47	1.01	1.20
S	0 to 1685	0.22	0.50	0.60	0.38	0.92	1.10
C	0 to 2471	0.18	0.60	0.75	0.30	1.11	1.37

TemPak Common Specifications

Storage Temperature: –40°C to +75°C, except for Y2003 and Y2009 is 0 to 40°C.
Operating Temperature: 0 to 50°C, except Y2003 and Y2009 is 0 to 40°C.
Relative Humidity: ⩽80%, non-condensing, from 0 to 50°C.
Shock and Vibration: Meets MIL-T-2800 specifications.

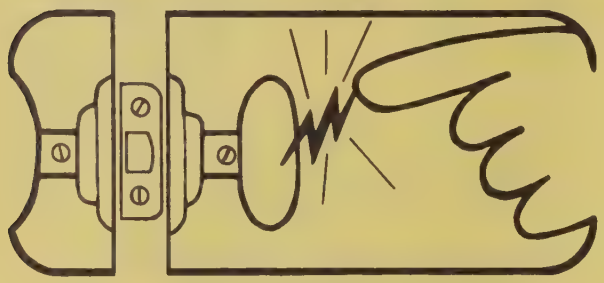
TemPak Case Dimensions

Style A: 5.72 cm H x 20.45 cm W x 32.64 cm D (2.25 in. H x 8.05 in. W x 12.85 in. D).
Style B: 8.20 cm H x 20.45 cm W x 32.64 cm D (3.23 in. H x 8.05 in. W x 12.85 in. D).
Style C: 10.49 cm H x 20.45 cm W x 32.64 cm D (4.13 in. H x 8.05 in. W x 12.85 in. D).

static awareness

A Message From

John Fluke Mfg. Co., Inc.

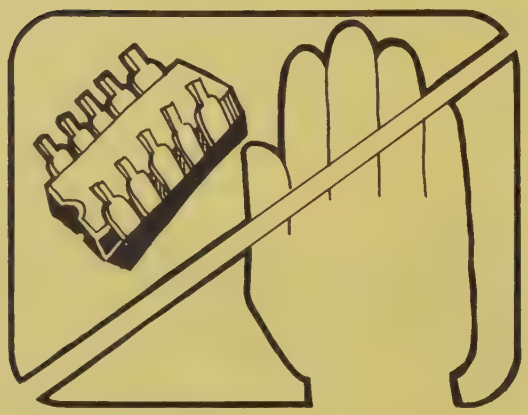


Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

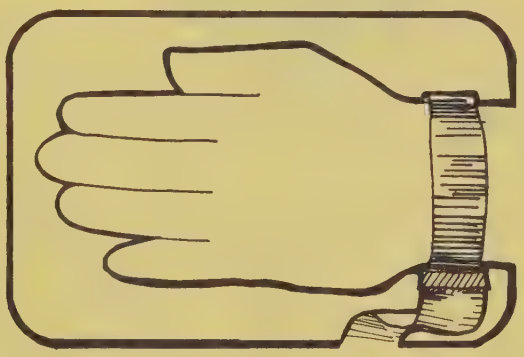
1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol "⊗".

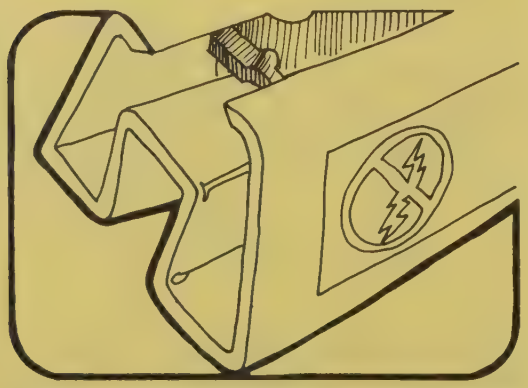
The following practices should be followed to minimize damage to S.S. devices.



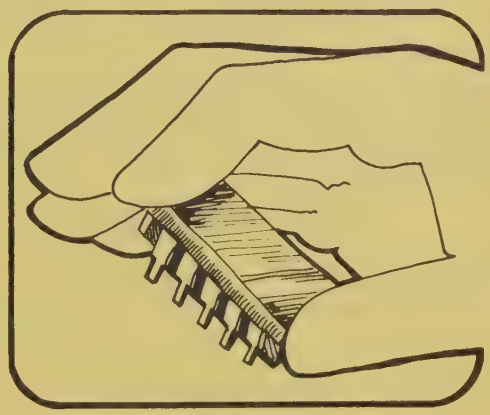
1. MINIMIZE HANDLING



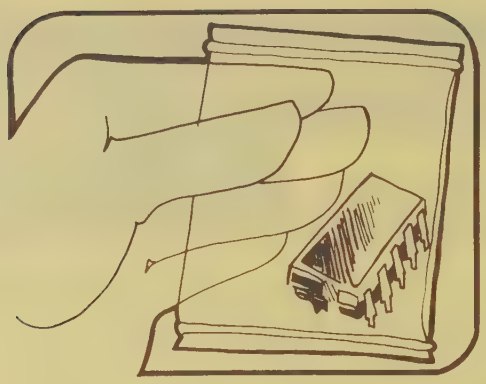
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES



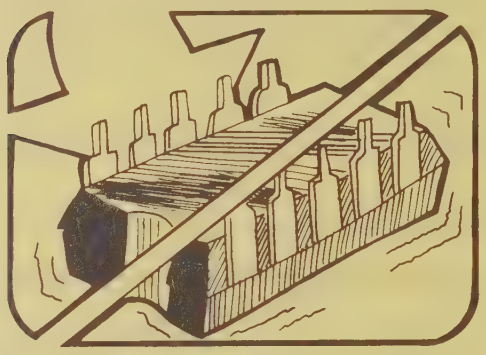
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



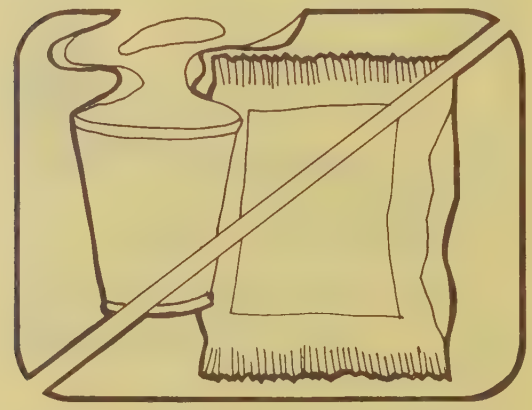
4. HANDLE S.S. DEVICES BY THE BODY



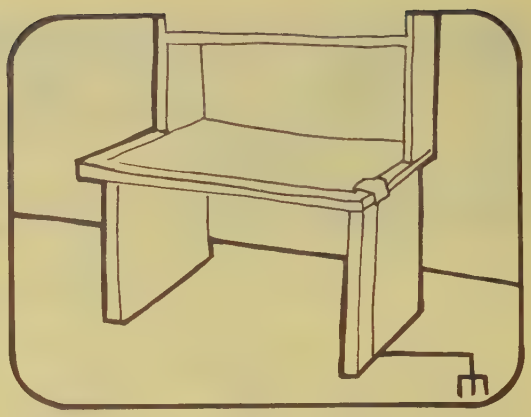
5. USE ANTI-STATIC CONTAINERS FOR HANDLING AND TRANSPORT



6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



7. AVOID PLASTIC, VINYL AND STYRAFOAM IN WORK AREA



8. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION

9. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

10. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

Anti-static bags, for storing S.S. devices or pcbs with these devices on them, can be ordered from the John Fluke Mfg. Co., Inc.. See section 5 in any Fluke technical manual for ordering instructions. Use the following part numbers when ordering these special bags.

John Fluke Part No.	Bag Size
453522	6" x 8"
453530	8" x 12"
453548	16" x 24"
454025	12" x 15"

Section 2
Operating Instructions

2-1. INTRODUCTION

2-2. This section of the manual contains information regarding installation and operation of the 2190A Digital Thermometer. It is recommended that the contents of this section be read and understood before any attempt is made to operate the instrument. Should any difficulties arise during operation, please contact your nearest Fluke Technical Service Center, or the John Fluke Mfg. Co., Inc.; P.O. Box 43210; Mountlake Terrace, WA 98043; Tel (206) 774-2211. A list of Technical Service Centers is located in Section 7 of the manual.

2-3. SHIPPING INFORMATION

2-4. The 2190A is packaged and shipped in a foam-packed container. Upon receipt of the instrument, a thorough inspection should be made to reveal any possible shipping damage. Special instructions for inspection and claims are included on the shipping carton.

2-5. If reshipment of the instrument is necessary, the original container should be used. If the original container is not available, a new one can be obtained from the John Fluke Mfg. Co., Inc. Please reference the instrument model number when requesting a new shipping container.

2-6. INPUT POWER

2-7. The 2190A will operate at any of four switch selected input line voltages. All operate at frequencies from 50 to 440 Hertz. A decal on the instrument rear panel defines the original setting of the line voltage selection switches. Refer to Section 4 of this manual for instruction on verifying or changing the input line voltage switch settings.

CAUTION

Before connecting the 2190A to the local ac line verify that the present setting of the instrument matches the local line voltage.

2-8. The rear panel ac input connector is a three-prong, U-ground connector which permits the instrument to be connected, via the power cord, to the applicable line voltage. The offset prong on this connector is connected to the 2190A transformer shield and should be connected through the power cord to a high quality earth ground. The Rear Panel external 12V dc connector accepts two wires from an external supply. The two receptacles are marked for polarity.

2-9. INSTALLATION

2-10. The 2190A and its individually packaged accessories are installed in PTI (Portable Test Instrument) cases. These cases are stackable, allowing the operator to fasten them together and transport a series of instruments as one unit. The maximum weight for the stacked units is forty pounds.

2-11. Prepare the 2190A for operation by plugging the input line power cord into the applicable power source or connecting the 12V dc external input connector to an external 12V dc source.

2-12. OPERATING FEATURES

2-13. The location of the 2190A controls, indicators and connectors are shown and described in Figure 2-1 and Table 2-1 respectively.

2-14. OPERATING NOTES

2-15. The following paragraphs describe various conditions that could effect operation of the thermometer. The operator should familiarize himself with these conditions prior to operating the 2190A.

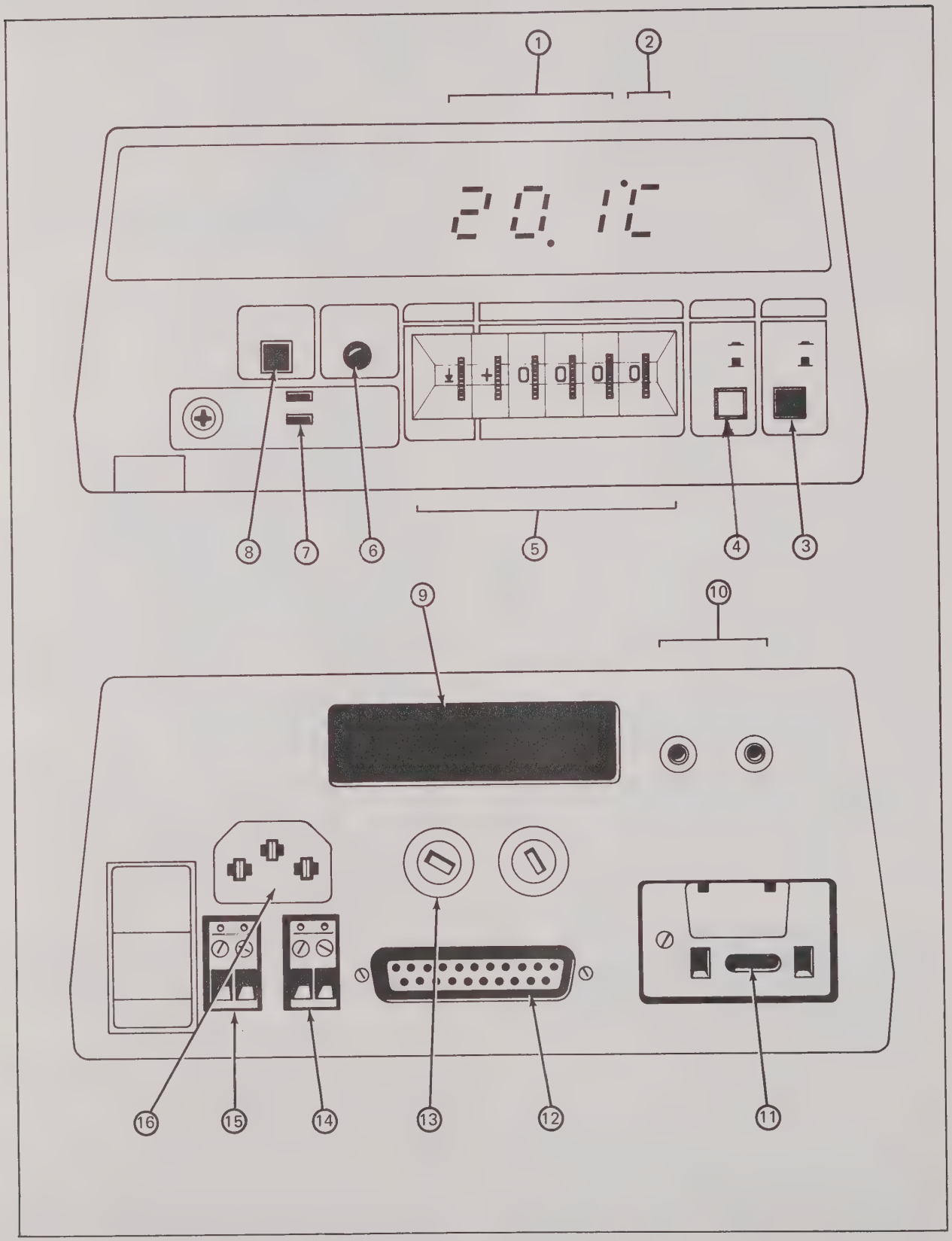


Figure 2-1. Controls and Indicators

Table 2-1. 2190A Controls, Indicators and Connectors

REF	NAME	FUNCTION
1	Digital Display	Displays a five digit readout of the measured input temperature. Leading zero suppression and a fixed decimal point are included. A minus sign is displayed for negative temperature measurements.
2	Temperature Scale Indicator	Displays the temperature scale represented by the digital display data; °C or °F.
3	Power Switch	Applies or removes power from the instrument.
4	SCALE	Selects the temperature scale for display; °C or °F.
5	LIMIT and FUNCTION	Used with the –006 Limit Option, if installed. Limit is a numeric set with thumbwheels to the value used by the selected function. FUNCTION, in combination with the LIMIT numeric sets an upper (>) or lower (≤) limit value which, if exceeded, will illuminate an indicator and close relay contacts accessible on the rear panel. The third function (△) causes the thermometer to display the difference between the actual reading and the value set on the LIMIT switches. The last two functions examine, and display, the maximum (↑) or minimum (↓) reading recorded in microcomputer since the last reset by the INITIALIZE MAX/MIN pushbutton switch.
6	LIMIT EXCEEDED	Part of the –006 Limits Option. Indicator illuminates when the preset limits have been ex exceeded.
7	CALIBRATION	Cover for calibration adjustments used in the calibration procedure.
8	INITIALIZE MAX/MIN	Part of the –006 Limits Option. Resets the accumulated maximum and minimum readings stored by the microcomputer.
9	DIGITAL OUTPUT	If Option –002 is installed, connector for the ASCII coded data for the output unit.
10	ANALOG OUTPUT	If Option –002 is installed, banana jack connector for an analog output of 1 mV per degree.
11	INPUT CONNECTOR	Connection and access point for Thermocouple Input Module with isothermal block for thermocouple connection and selection.
12	ACCESSORY CONNECTOR	Cable connector for electrical connection from accessory units.
13	FUSES	Fuses for the input line power (F1) and the external 12V dc input (F2).
14	LIMITS	If the Limits feature is installed, provides an output terminal for a relay contact closure to signal when the set limits have been exceeded.
15	±12 VDC	Input terminals for the external 12V dc power source.
16	LINE VOLTAGE CONNECTOR	Input connector for the input line voltage.

2-16. Option Information

2-17. Supplementary operating instructions are necessary when operating a 2190A equipped with one of the available options. Detailed information regarding the operation of each available option is given in Section 6 of this manual, Option and Accessory Information.

2-18. Fuse Replacement

2-19. The ac line input and external dc input are individually fuse protected. Both fuses are readily accessible on the outside of the rear panel. The ac line input fuse (F1) should be replaced with a 1/8A fast acting fuse if either 100 or 120 volts has been selected as the input line voltage. Use a 1/16A replacement if 220 or 240 volts have been selected. The external dc input (F2) requires a 3/4A Slo-blo fuse for a replacement.

2-20. Overload Thermocouple Indication

2-21. The front panel display, in addition to providing a measurement reading, provides an indication of an overload on the input thermocouple. When the measurement range of the selected thermocouple is exceeded the display flashes either the full scale positive or full scale negative reading dependent on the polarity of the overload. The blinking indication does not necessarily indicate the instrument is exposed to a damaging input condition.

2-22. Open Thermocouple Indication

2-23. If the thermocouple is open, or not connected to the input terminals, the display flashes the characters "O.C.". A signal from the rear panel relay contacts can also be obtained if the Limits Option (-006) is installed. To accomplish this, select either the positive (+OL) or negative (–OL) position on S4 located on the Main PCB (refer to Section 4 for access to the Main PCB), depending upon whether the limits option is set to greater than (>), or less than or equal (≤). If the limits are set for >, the S4 switch should be set to +OL for an open thermocouple to close the relay contacts for a signal. Conversely, for a signal with a ≤ limit –OL should be selected.

2-24. OPERATION

2-25. Thermocouple Installation

2-26. The 2190A is designed to operate using any of seven switch selectable thermocouples. These are available in two combinations, either J, K, T, C, and R or J, K, E, R, and S. The instrument is configured with the microcomputer program required by the customers order. Select the desired thermocouple range using the following procedure:

1. Remove the Thermocouple Input Module from the instrument through the access port on the rear panel.

2. Connect the selected thermocouple to the input terminals on the isothermal block.

3. Set the thermocouple selector switch to the setting shown in Table 2-2 and on the pcb beside the isothermal block, for the thermocouple installed.

4. Connect the Thermocouple Input Module to the instrument Main PCB through the access port on the rear panel.

Table 2-2. Thermocouple Input Switch Settings

SELECTION CODE	SWITCH POSITIONS 1	2	4	8	T/C TYPE or OPERATION
0	OFF	OFF	OFF	OFF	J
1	ON	OFF	OFF	OFF	K
2	OFF	ON	OFF	OFF	T
3	ON	ON	OFF	OFF	E
4	OFF	OFF	ON	OFF	C
5	ON	OFF	ON	OFF	S
6	OFF	ON	ON	OFF	R
7	ON	ON	ON	OFF	Display Blanked
8	OFF	OFF	OFF	ON	Calibration
9	ON	OFF	OFF	ON	Calibration

2-27. Thermometer Operation

2-28. Operate the 2190A Thermometer using the following procedure:

1. Verify the instrument has the correct thermocouple connected or install the desired thermocouple using the procedure previously gived in this section.

2. Connect the input line cord to the applicable power source.

3. Select the temperature scale desired for display with the Front Panel SCALE switch (in for °C and out for °F).

NOTE

If Option -006 is installed the FUNCTION thumbwheels must be set for Limits (> or ≤) for a direct temperature reading.

4. Select POWER ON.

NOTE

Refer to Section 6 of this manual or applicable accessory manuals for instructions on the operation of any installed options or connected accessories.

5. Expose the thermocouple probe to an unknown temperature, or the temperature to be monitored, within the thermocouples specified range (see Specifications in Section 1).

6. The probe temperature, in the scale selected is displayed on the front panel.

Section 3
Theory of Operation

3-1. INTRODUCTION

3-2. This section of the manual contains an overall functional description followed by a brief circuit analysis of the 2190A Digital Thermometer. Simplified circuit diagrams are provided, as necessary, to supplement the text. Detailed schematics are given in Section 8 of this manual.

3-3. OVERALL FUNCTIONAL DESCRIPTION

3-4. The Model 2190A Digital Thermometer, shown in Figure 3-1, is a 5-digit microcomputer controlled thermocouple thermometer capable of resolving 0.1°C or 0.1°F over temperature range of –242° to 2471°C or –405° to 4480°F. It features a reference-junction compensator (eliminating the need for an ice bath reference junction), dual-slope A/D conversion technique, microcomputer control logic (providing linearization programs for the J, K, T, C, and R version or the J, K, E, R, and S version thermocouple types), and a 5-digit display with temperature scale indicator.

3-5. In operation, the 2190A executes a continuous series of measurement cycles to update the temperature display. The measurement cycle is controlled entirely by the microcomputer and includes three major subcycles; the Auto-Zero, Integrate and Read periods. Each subcycle controls the operation of the analog section of a dual-slope integrator which, in turn, generates a compare output, which is used by the microcomputed to generate the proper control signals. (In addition to these major subcycles a recovery signal is applied at the end of the read period to assist the Auto-Zero period.)

3-6. The configuration of the analog section during each phase of the measurement cycle, is established by the condition of microcomputer controlled FET switches. The measurement cycle begins with the Auto-Zero period. During this period, the input to the Buffer Amplifier is connected to ground through a FET switch and the accumulated dc offset voltages present in the analog section are sampled and held by the Auto-Zero capacitor. This voltage is used later in the measurement cycle to cancel measurement errors introduced by offset voltages present in the analog circuitry. As a result, the final measurement is proportional to the thermocouple probe output voltage and does not include offset errors.

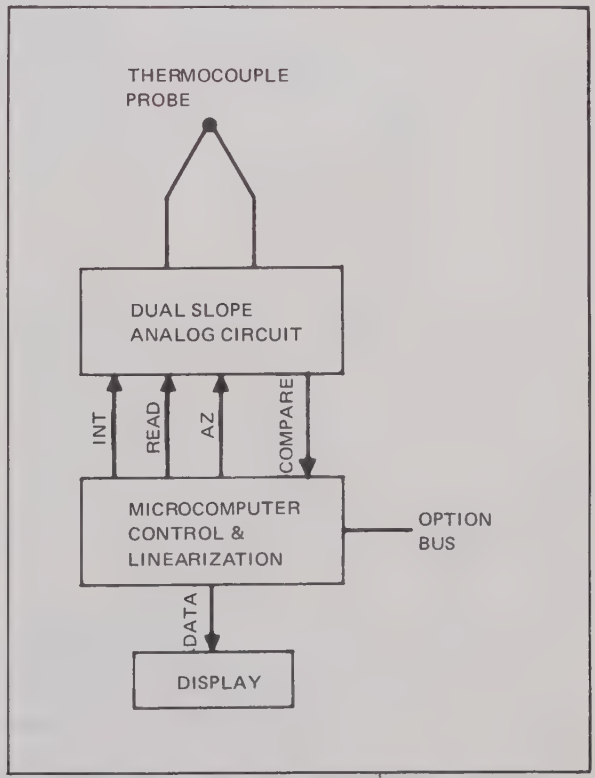


Figure 3-1. 2190A Simplified Block Diagram

3-7. During the Integrate period, the thermocouple input voltages (probe voltage and input terminal voltages) are applied to the integrator and the algebraic sum of these voltages is integrated over a 100 ms period. At the end of this period the thermocouple input voltages are removed from the integrator and the Read period is started.

3-8. A reference voltage is applied to the integrator during the Read period, causing the integrator capacitor to be discharged at a linear rate. When the integrator output reaches the voltage stored on the Auto-Zero capacitor a compare signal is generated to end the Read period. The duration of the Read period is translated by the microcomputer to provide a digital indication proportional to the thermocouple probe voltage.

3-9. To compensate for the error voltage present on the input terminals the microcomputer configures the analog portion to do a complete conversion cycle on the reference junction voltage every 11th read cycle. This voltage is generated by a transistor which is at the same temperature as the input terminals. The microcomputer uses the number generated during the Read period to compensate the input voltage and display the actual probe temperature.

3-10. CIRCUIT ANALYSIS

3-11. Circuit analysis of the 2190A is discussed in two sections; digital and analog. The digital section is covered first and particular attention is paid to the control it exercises on the analog section. The analysis of the analog section covers the analog measurement circuitry and the power supply.

3-12. Digital Section

3-13. The digital section of the 2190A consists of a single-chip microcomputer (U4), which has a self-contained, programmed read only memory; a hex CMOS open drain buffer (U3); and an LED display. Its function is to convert the non-linear thermocouple probe voltage, as measured by the analog section, into a linear digital display, provide the necessary control signals to the analog section and to provide control for all accessories on an accessory bus. The 2190A LED display provides a direct reading of the probe temperature in °C or °F.

3-14. The microcomputer contains all 2190A program, control logic, and linearizing capability and provides the display with all signals necessary to update the display. The linearization of the non-linear input signal is accomplished by selecting one of seven programs which compute the correct temperature using a 4th order curve fit approximation of the probe output. The operating program is selected to match a particular thermocouple type and is enabled by the numeric setting corresponding to the thermocouple type in use. The switch is located on the thermocouple input assembly next to a table showing the switch setting applicable to the thermocouple type in use.

3-15. Measurement data is continuously strobed out of the microcomputer in decoded-seven-segment, character-serial format and sent to the LED display. With an overload condition the display flashes on and off. An "O.C." display indicates an open thermocouple probe condition.

3-16. The basic measurement cycle shown in Figure 3-2, consists of three major subcycles; a 100 ms minimum Auto-Zero period, a 100 ms Integrate period, and a variable Read period. The total measurement cycle time consists of 300 ms; 100 ms to integrate, up to 100 ms to the Read period and the remaining time to the Auto-Zero period. (Auto-Zero time will vary from 100 to 200 ms.) To accomodate settling times in the analog section a $\Delta 2$, (1 ms nominal) hold signal is inserted at the beginning and at the end of the Integrate period.

3-17. Analog Section

3-18. ANALOG MEASUREMENT CIRCUIT

3-19. The analog circuit is shown in simplified form in Figure 3-3. It consists of a thermocouple input circuit, a reference-junction compensator, a votage reference, a buffer amplifier, an integrator, a gain stage, a comparator and a combination of FET switches. The switches are shown in their open state and are closed by the measurement cycle commands generated by the microprocessor.

3-20. The Thermocouple Input circuit consists of an R-C filter and a pair of voltage protection diodes. The difference between the thermocouple probe voltage and the input terminal voltage is passed through the filter and appears at FET switch Q15. The R-C filter increases the normal mode rejection capability of the 2190A.

3-21. The Reference-Junction Compensator consists of an isothermal block, a pair of screw type input terminals and a transistor temperature sensor, (all on the Thermocouple Input Assembly). The isothermal block maintains a negligible temperature differential between the input terminals and the temperature sensing transistor. Thermocouple voltages introduced by the dissimilar metals at the input terminals vary as the isothermal block adjusts to ambient temperature. Temperature changes are sensed by the forward biased transistor to produce a correction voltage which is read by the analog measurement circuitry every eleven cycles. The reading is saved by the microcomputer and is used to compensate for the error voltages present at the input

terminals. Predictable characteristics of a forward-biased P-N junction allow the Reference-Junction Compensator to function over a wide temperature range. This correction voltage occurs at FET switch Q17.

3-22. The voltage reference consists of a thin-film resistor network supplied by an accurate 6.2V dc reference voltage. The divider is set to provide 100 mV and 200 mV. These voltages appear at FET switches Q13 and Q12, respectively.

3-23. The Buffer, Integrator, Gain Stage, and Comparator Amplifiers combine to perform the analog functions of the Integrate, Read, and Auto-Zero periods. The Buffer is used to provide integrator inputs during all three periods. The Integrator integrates the Buffer output voltage during the Integrate and Read periods and, in combination with the Gain Stage, functions as a closed-loop amplifier during the Auto-Zero.

3-24. During the first phase of each measurement cycle, the analog section goes through an Auto-Zero period. During this time, four auto-zero switches (Q12, Q16, Q6 and Q10) are closed by the Auto-Zero command from the microprocessor. Two of the switches (Q12 and Q16) charge the reference capacitor to 100 mV. Switch Q16 also zeroes the input to the buffer amplifier. The third switch, Q6 connects the Integrator and Gain Stage into a closed-loop configuration and allows the Auto-Zero cap (C10) to charge to a value which is proportional to the algebraic sum of all the offset voltages present in the Buffer, Integrator, and Gain Stage. At the end of the Auto-Zero period switches Q12, Q16, Q6 and Q10 are opened. The VREF capacitor and the Auto-Zero capacitor retain their charge for use later in the measurement cycle.

3-25. The Integrate period starts on the leading edge of the integrate command from the microcomputor; switch Q15 is closed and switch Q8 opened. The thermocouple input voltage is applied through switch Q15 to the Buffer input. After a 1 ms settling period, switch Q8 closes and the Buffer output is applied to the Integrator for 100 ms. As the integrator capacitor charges, the Integrator drives the comparator (through the Gain Stage) to either 0 or +5V dc to indicate the polarity of the thermocouple input voltage, negative or positive, respectively. At the end of the Integrate period, the integrate capacitor is charged to a level and polarity which are proportional to the thermocouple input voltage and switches Q15 and Q8 return to the open state.

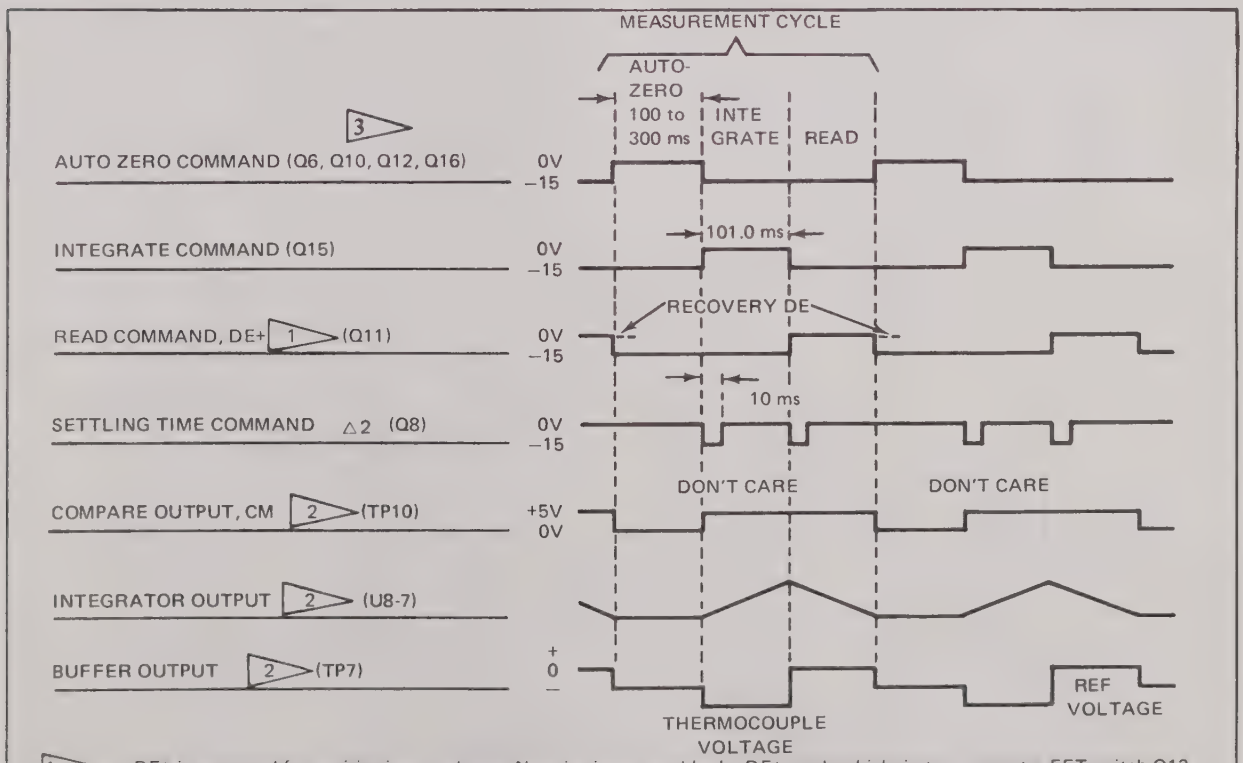


Figure 3-2. Measurement Cycle Waveforms

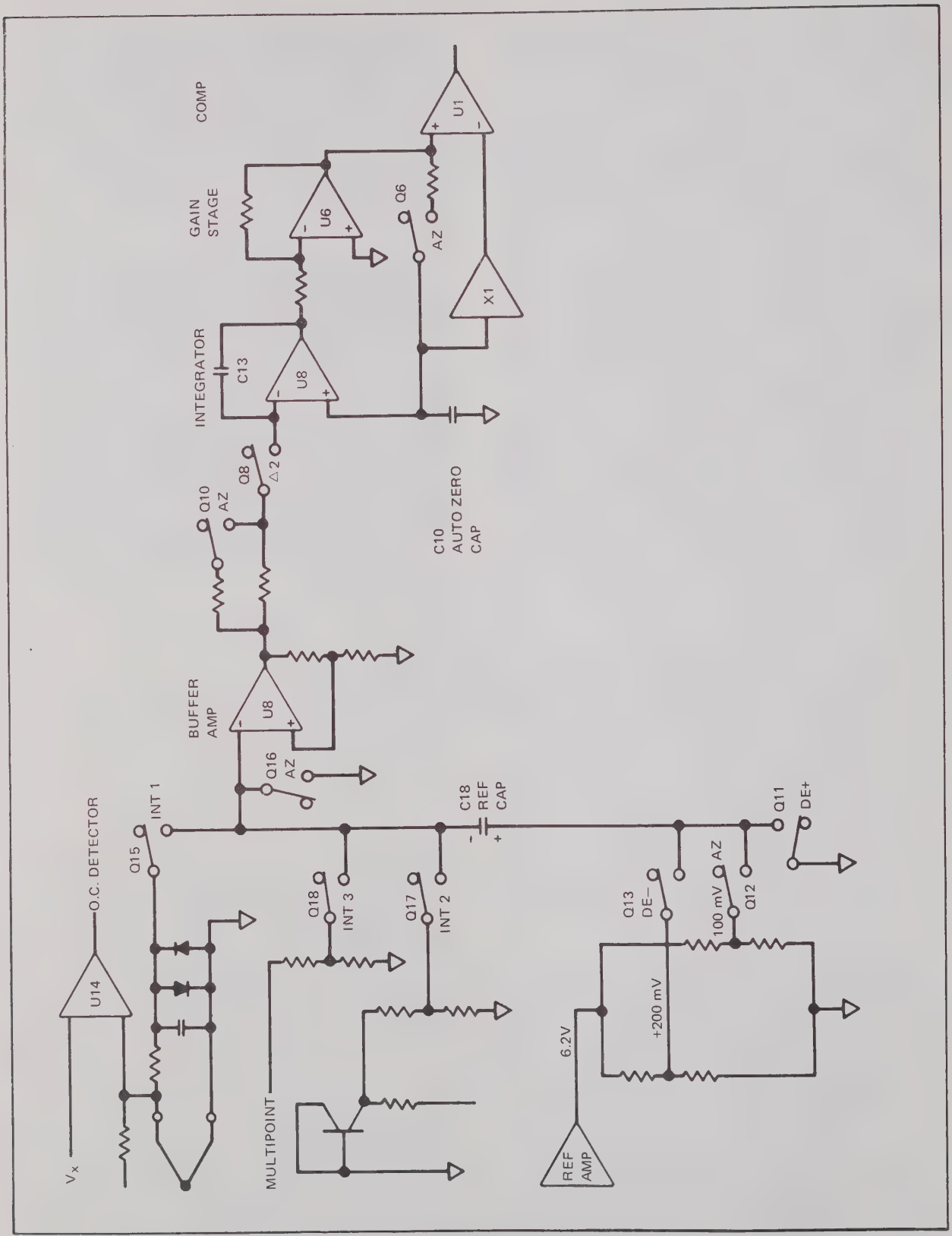


Figure 3-3. Simplified Schematic — Analog Section

3-26. The Read period starts at the end of the Integrate period and one-of-two Read modes is enabled depending upon the input polarity sensed by the comparator during the Integrate period. If a positive input is sensed, a positive Read mode is enabled. Similarly a negative Read mode is enabled when a negative input is sensed.

3-27. If the positive Read mode is commanded, FET switch Q11 is closed. This grounds the positive end of the VREF capacitor which effectively applies –100 mV to the input of the buffer.

3-28. If the negative Read mode is commanded, switch Q13 is closed connecting the positive end of the VREF capacitor to +200 mV. Therefore, the voltage applied to the Buffer is the algebraic sum of 200 mV and the voltage across the reference capacitor. This effectively applies +100 mV to the input of the buffer.

3-29. After a 1 ms settling time, switch Q8 closes and the Buffer output voltage is applied to the Integrator input, causing the integrator capacitor to discharge at a linear rate determined by the reference voltage. The discharge continues until the integrator voltage reaches the comparator trip point, which is referenced to the voltage on the Auto-Zero capacitor. When this level is reached the comparator changes state, commanding the microcomputer to terminate the Read period. To facilitate auto-zero, the microcomputer then calls a reference voltage opposite in polarity to the one previously used. When the integrator again reaches the trip point, the microcomputer immediately begins the auto-zero period.

3-30. Offset voltages present during the Integrate and Read periods are cancelled by offset voltages that were sampled and held during the Auto-Zero period. However, during conversion within the microcomputer, the temperature corresponding to the reference junction voltage is added to the measurement data and, as a result, the displayed temperature is equal to the thermocouple probe temperature.

3-31. O.C. DETECTOR

3-32. The open thermocouple detector (U14 and its associated circuitry) on the thermometer is used to determine whether or not the impedance at the input terminals exceeds a predetermined level. It, therefore, provides an indication of a broken or faulty thermocouple. A squarewave is applied to the input of the thermometer and its magnitude is compared to a reference squarewave. If the reference is exceeded, an open circuit condition is detected. This occurs at a nominal 2 kΩ.

3-33. POWER SUPPLY

3-34. The 2190A power supply consists of power transformer (or 12V dc input), fuses, power input cord, DC to DC converter circuitry and voltage regulating circuitry. The function of the power supply is to provide +5, +15, and –15 ac operating voltages for the 2190A circuitry. The power supply can be driven from AC line or 12V dc external source. The DC to DC conversion and voltage regulation are accomplished using conventional power supply design techniques.

Section 4
Maintenance

WARNING

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

4-1. INTRODUCTION

4-2. This section of the manual provides information about warranty, factory service, maintenance, performance testing, routine recalibration and recalibration after repair. The performance test is recommended when the instrument is received and later as a preventive maintenance tool or for testing after repair. The test verifies performance at several temperatures within the range of a given thermocouple type. Specifications are provided both for annual and for a more precise 90-day performance-testing cycle.

4-3. SERVICE INFORMATION

4-4. The instrument is warranted for a period of one year upon delivery to the original purchaser. The WARRANTY is located on the back of the title page located in the front of this manual.

4-5. Factory authorized calibration and service for each Fluke product is available at various world-wide locations. A complete list of these service centers is included in Section 7 of this manual. If requested, an estimate will be provided to the customer before any work is begun on instruments that are beyond the warranty period.

4-6. GENERAL MAINTENANCE

4-7. Instrument Disassembly

4-8. Removal of the instrument from its case is necessary only for maintenance. Disassemble the thermometer using the following procedure:

1. Remove the Thermocouple Input PCB Assy through its access port in the rear panel.
2. Remove the four screws on the bottom of the instrument that secure the two halves together and lift the top cover free.
3. Remove the Output Option, if installed and required, by removing the three screws connecting it to the Main PCB, disconnecting the interconnect cables at J1 and J3, and lifting the Option PCB clear.
4. Remove the screw securing the center of the Main PCB to the bottom portion of the case.
5. Lift the Main PCB, complete with Front and Rear Panels, clear of the case.
6. Remove the Front Panel, if required, by disconnecting the guard screw at the lower right corner, disconnecting the Front Panel

Interconnect cable at J6, disconnecting, if installed, the Limits Option interconnect cable at J4, and moving the Front Panel forward.

7. Remove the Rear Panel, if required, by removing the three screws attaching it to the Main PCB, disconnecting the wires from the input line power connector, unsoldering the wires from two fuse holders and moving the rear panel free.

8. Perform reassembly in the reverse order.

4-9. Input Line Power Selection

4-10. Input line power voltage is selected by positioning the slot on two switches. Figure 4-1, shows the switches on the right edge of the Main PCB set for 120 volt AC operation. Table 4-1, lists the switch settings for other line voltages available.

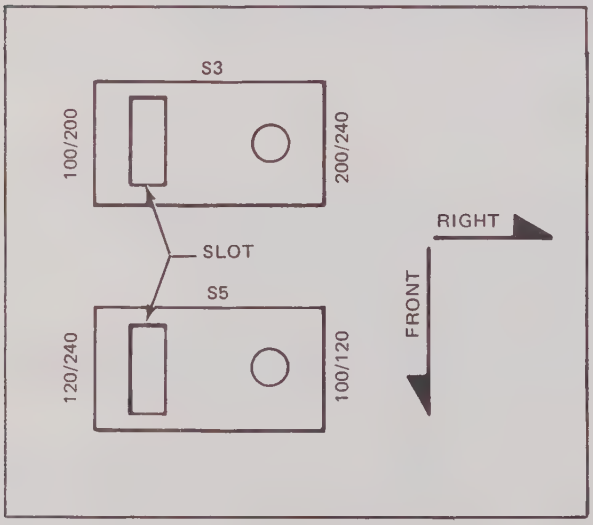


Figure 4-1. Line Voltage Selection Switches

Table 4-1. Line Voltage Selection Switches Positioning

TO SELECT VOLTAGE	S3 SLOT (REAR SW)	S5 SLOT (FRONT SW)
100	Left	Right
120	Left	Left
200	Right	Right
240	Right	Left

4-11. Cleaning

4-12. Clean the instrument periodically to remove dust, grease and other contamination. Use the following procedure:

CAUTION

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. They will react with plastic materials used in the manufacture of the instrument.

1. Clean the front panel and case with a soft cloth dampened with a mild solution of detergent and water.

2. Clean the surface of the pcb using clean, dry air at low pressure (≤20 psi). If grease is encountered, spray with Freon T.F. Degreaser or anhydrous alcohol and remove grime with clean, dry air at low pressure.

4-13. Fuse Replacement

WARNING

DISCONNECT THE UNIT FROM LINE POWER BEFORE ATTEMPTING FUSE REPLACEMENT.

4-14. The 2190A has two fuses, both accessible on the rear panel. F1 is for the input line power and should be replaced, when necessary, with a 1/8A AGC (fast acting) fuse when the input line power selected is 100V or 120V. When the input power selected is 220V or 240V, F1 should be replaced with a 1/16 AGC fuse. F2 is for the 12V dc external power and requires 3/4A MDL fuse.

4-15. Service Tools

4-16. No special tools are required for maintenance or repair.

4-17. PERFORMANCE TEST

4-18. The Performance Test verifies instrument performance to specifications and may be used for initial acceptance, verifying calibration, or as an aid in troubleshooting. If the thermometer fails to meet specifications either the Calibration Adjust Procedure or Troubleshooting should be performed, as determined by qualified service personnel.

4-19. Table 4-2, lists the equipment required for the Performance Test and Calibration Adjustment Procedure. If the recommended model of test equipment is not available, a substitute that meets the minimum use specifications may be used. The test should be conducted with an ambient temperature of 25±5°C (77.0±3.6°F).

±2°C

Table 4-2. Test Equipment Requirements

TEST EQUIPMENT	MINIMUM USE SPECIFICATIONS	RECOMMENDED MODEL
Thermocouple Probes	Type J, K, T, E, R, S, C, ANSI C96.1	Omega TJ36 Series, Grounded Sheath
Thermocouple Wires	Type J, K, T, E, R, S, C	Omega
Mercury Thermometer (either °C or °F)	0.02° C resolution 0.05° F resolution	Princo Model ASTM56C Princo Model ASTM56F
Dewar Flask/Cap	1-pint capacity	Thermos
DC Voltage Calibrator	Output Voltage 0 to 10V Accuracy: 0.002% Resoution: 100 uV	Fluke Model 343A
Voltage Divider 100:1 Kelvin-Varley Divider (Shunt output with 1 uF capacitor)	Ratio: 0.005%	Fluke Y2022 or Fluke 720A or Fluke 750A
Variable Line-Voltage Transformer	100, 115, 230V ac, as required, ±10%	General Radio VARIAC W5HM
Decade Resistor	Accuracy: 1% Ranges: 1k, 10k, and 100k	General Radio 1434
Voltmeter	100 uV resolution	Fluke 8800A

4-20 Use the following procedure for the Performance Test:

1. Turn the POWER switch OFF and remove the line power cord from the line voltage source.
2. Select the switch position on the Thermocouple Input module corresponding to the thermocouple type used.
3. Connect the equipment as shown in Figure 4-2.
4. Verify the POWER switch is OFF, then adjust the line voltage transformer for the nominal input line voltage.
5. Turn the POWER switch ON.
6. Allow the thermometer to stabilize (at least 20 minutes).
7. Select the temperature scale of the mercury thermometer in the lag bath.
8. Select that portion of Table 4-3, dealing with the thermocouple in use and select the first divider output in millivolts for that type.
9. Add algebraically the reading of the mercury thermometer in the lag bath to the 2190A display.

NOTE

With the divider output at zero volts the thermometer reads the lag bath temperature.

10. Is the remainder equal to the applicable specification in Table 4-3?
11. Repeat steps 8,9 and 10 for the remaining voltages for the installed thermocouple types as desired.
13. Set the line voltage transformer for line voltage minus ten percent and repeat the test for one thermocouple type.
14. Set the line voltage transformer for line voltage plus ten percent and repeat the tests for one thermocouple type.

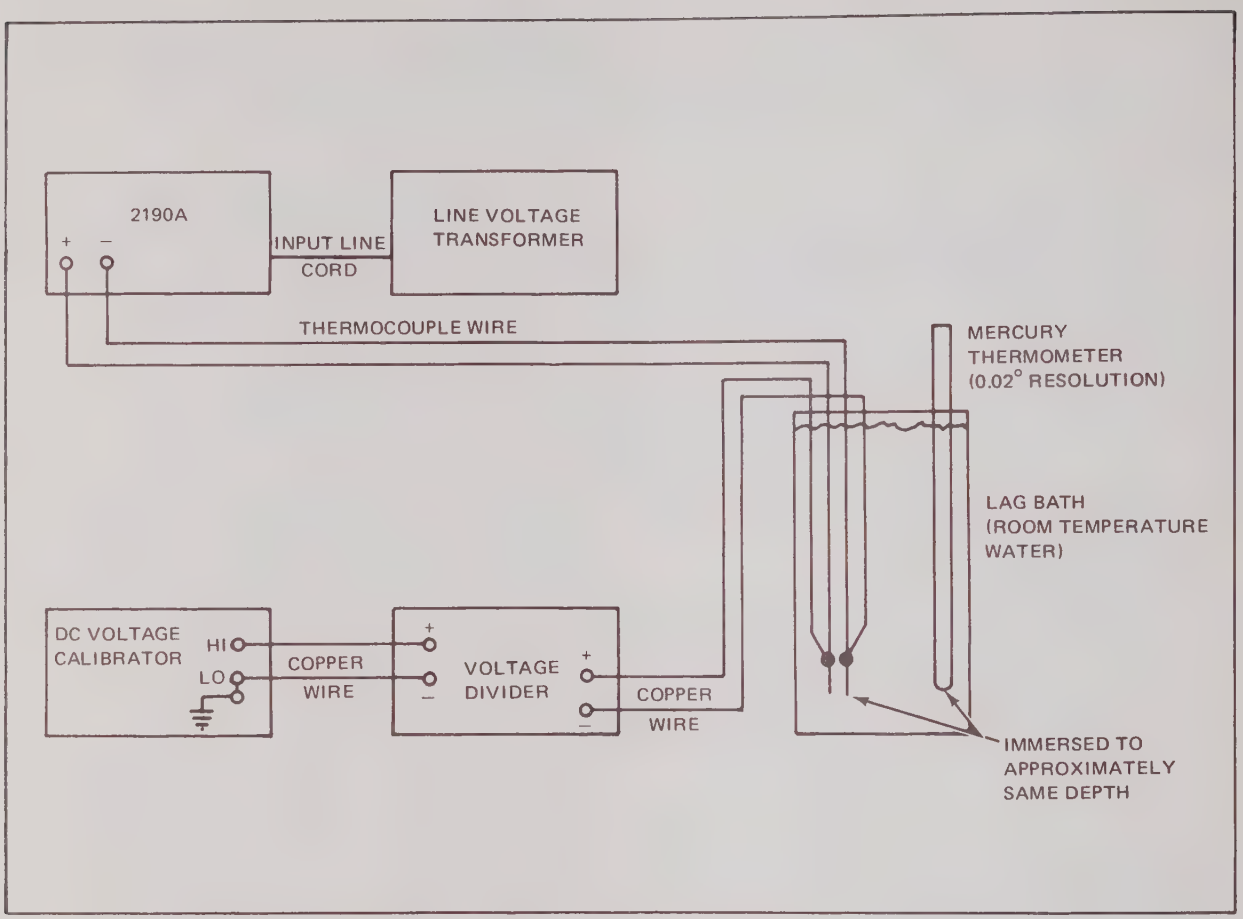


Figure 4-2. Equipment Connections

15. Set the line voltage transformer for the input line voltage.

16. Disconnect the thermocouple from the input terminals.

17. The 2190A flashes "O.C.".

4-23. CALIBRATION ADJUSTMENT PROCEDURE

4-22. The thermometer should be calibrated at either 90 day or annual periods, depending upon the accuracy desired, and any time that repairs are made to the instrument. Either scale can be verified by executing the Performance Test previously given. The microcomputer can also be changed without effecting the calibration of the instrument.

4-23. Equipment Preparation

4-24. Prepare the equipment for calibration using the following procedure:

1. Remove the top cover from the instrument.

2. Select switch position 9 (CAL) on the Thermocouple Input module to disable the reference junction circuitry.

3. Connect the equipment as shown in Figure 4-3. Refer to Table 4-2 for the applicable test equipment models.

NOTE

Insure the instrument warm-up period has been sufficient to reach rated accuracy (at least 20 minutes).

4. Select the desired temperature scale.

NOTE

If the Limits Option is installed select the LIMITS (≤ or >) function.

Table 4-3. Performance Test Values

TYPE	SW	DIVIDER OUTPUT mV	°F		°C	
			90 DAY	1 YEAR	90 DAY	1 YEAR
J	(0)	−5.553 −2.483 23.317	−190 ± 0.2 −60.0 ± 0.2 800.0 ± 0.2	−190 ± 0.2 −60.0 ± 0.2 800.0 ± 0.3	−123.3 ± 0.2 −51.1 ± 0.2 426.7 ± 0.2	−123.3 ± 0.2 −51.1 ± 0.2 426.7 ± 0.2
K	(1)	−4.230 −1.929 26.975 52.939	−190 ± 0.3 −60 ± 0.3 1200 ± 0.5 2400 ± 0.7	−190 ± 0.3 −60 ± 0.3 1200 ± 0.5 2400 ± 0.7	−123.3 ± 0.2 −51.1 ± 0.2 648.9 ± 0.3 1315.6 ± 0.4	−123.3 ± 0.2 −51.1 ± 0.2 648.9 ± 0.3 1315.6 ± 0.4
T	(2)	−6.105 −4.009 8.062 20.458	−400 ± 0.3 −190 ± 0.3 350 ± 0.3 740 ± 0.4	−400 ± 0.3 −190 ± 0.3 350 ± 0.3 740 ± 0.4	−240.0 ± 0.2 −123.3 ± 0.2 176.7 ± 0.2 393.3 ± 0.2	−240.0 ± 0.2 −123.3 ± 0.2 176.7 ± 0.2 393.3 ± 0.2
E	(3)	−9.604 −6.471 35.562 75.024	−400 ± 0.3 −200 ± 0.3 900 ± 0.3 1800 ± 0.6	−400 ± 0.3 −200 ± 0.3 900 ± 0.4 1800 ± 0.6	−240.0 ± 0.2 −128.9 ± 0.2 482.2 ± 0.2 982.2 ± 0.3	−240.0 ± 0.2 −128.9 ± 0.2 482.2 ± 0.2 982.2 ± 0.3
C	(4)	0.522 19.947 36.539	100 ± 0.3 2000 ± 0.6 4100 ± 1.1	100 ± 0.3 2000 ± 0.7 4100 ± 1.2	37.8 ± 0.2 1093.3 ± 0.4 2260.0 ± 0.6	37.8 ± 0.2 1093.3 ± 0.4 2260.0 ± 0.6
R	(5)	1.508 8.141 20.275	400 ± 0.4 1500 ± 0.6 3100 ± 0.9	400 ± 0.4 1500 ± 0.7 3100 ± 1.0	240.0 ± 0.3 815.6 ± 0.4 1704.4 ± 0.6	240.0 ± 0.3 815.6 ± 0.2 1704.4 ± 0.6
S	(6)	1.962 7.514 17.993	500 ± 0.3 1500 ± 0.5 3100 ± 0.8	500 ± 0.4 1500 ± 0.6 3100 ± 0.9	260.0 ± 0.2 815.6 ± 0.3 1704.4 ± 0.5	260.0 ± 0.2 815.6 ± 0.3 1704.4 ± 0.5

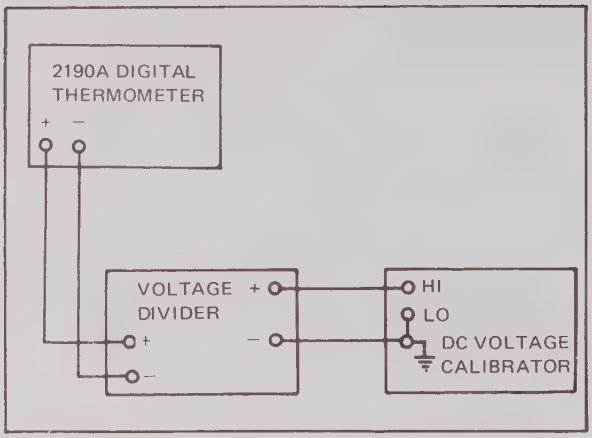


Figure 4-3. Calibration Adjustment Connections

4-25. Zero Adjustments

4-26. Perform Zero Adjustment using the following procedure:

1. Select a thermometer input, from the voltage divider, of 10.2 μV dc.

2. Record the thermometer display.

3. Reverse the polarity of the input by reversing the polarity of the calibrator output.

4. Record the thermometer display.

5. Adjust ZERO (R31) through the front panel access port and repeat steps 1 through 4 as required to obtain the same value in both steps 2 and 4.

6. Adjust R14 for a thermometer display of 10.0, of the same polarity as the input.

7. Connect a test DMM between TP16 (HI) and TP1 (LO).

8. Adjust R17 for a DMM reading between 6.1999 and 6.2001V dc. Ignore any thermometer display.

4-27. Reference Adjustments

4-28. Perform the Reference Adjust using the following procedure:

1. Select a thermometer input, from the voltage divider, of 99 mV dc.

2. Adjust +FS (R29) through the front panel access port for a display between 98999 and 99001.

3. Reverse the polarity of the input by reversing the polarity of the calibrator output.

4. Adjust –FS (R30) through the front panel access pot for a display between 98999 and 99001.

5. Select a thermometer input, from the voltage divider, of 45 mV dc and verify the thermometer reads between 44999 and 45001.

4-29. Reference Junction Adjustment

4-30. Perform the Reference Junction Adjustment using the following procedure:

1. Disconnect the voltage divider from the calibrator and the thermometer.

2. Select a calibrator output of +0.5785V dc.

CAUTION

Verify the calibrator output is correct before applying it to the instrument.

3. Connect the calibrator between TP1 (HI) and TP17 (LO), select switch position 1 (K) on the Thermocouple Input PCB Assy, and short the Thermocouple + and – input terminals with a short piece of copper bus wire.

4. Adjust R5 for a thermometer display of 77.0° F.

5. Disconnect the calibrator from the thermometer and remove the short on the thermocouple input terminals.

4-31. Thermocouple Input Calibration

4-32. Perform the Thermocouple Input calibration using the following procedure:

1. Connect a thermocouple to the thermometer input terminals (K-type preferred), select the applicable switch position, and insert the probe into a lag bath.

2. Allow the system to stabilize, then adjust R1 on the Thermocouple Input module, through the rear access port, for a temperature display equal to the reading of the lag bath thermometer.

3. Calibration of the 2190A is complete. Disconnect all test equipment from the instrument.

4-33. SELECTED COMPONENT REPLACEMENT AND ADJUSTMENT

4-34. Bias Resistor Replacement and Adjustment

4-35. If the reference-junction transistor (Q1 on the Thermocouple Input PCB Assy) is replaced or the negative supplies repaired the reference-junction bias resistor R3 must also be replaced. R3 is a selected resistor and must be individually matched to Q1. Prior to the matching procedure calibrate the instrument using the standard procedure through the Reference Junction Adjustment and then replace the Thermocouple Input Calibration portion of the procedure with the following:

1. Connect a thermocouple probe to the input terminals and select the applicable switch setting on the Thermocouple Input PCB Assy (K-type thermocouple preferred) and insert the probe into a lag bath.

2. Center the reference-junction potentiometer, R1.

3. Connect a decade box (see Table 4-2) in place of the reference-junction bias resistor.

4. Adjust the decade resistance box for the value from Table 4-4 that causes the temperature to read closest to the lag bath temperature, as monitored on the mercury thermometer.

5. Remove power, disconnect the decade box and connect the resistor selected from the table.

6. Reapply power, allow the system to stabilize at its rated accuracy (at least 20 minutes), then adjust R1 through the rear panel access port for a temperature display equal to the reading of the lag bath mercury thermometer.

7. Calibration and component selection is complete. Disconnect all test equipment from the instrument.

4-36. Multipoint Potentiometer Adjustment

4-37. The multipoint potentiometer (R57) is set at the factory and should not require further adjustment unless one of the other resistors in the divider (R1 and R2) or the capacitor (C19) require replacement. Adjustment of the potentiometer requires that a Y2001 Multipoint Selector be connected to the instrument. Adjust R57 subsequent to replacement of any of the four affected components (C19, R1, R2, R57) using the following procedure:

1. Connect a Y2001 Multipoint Selector to the instrument.

2. Short the input to one channel on the Y2001 and select the shorted channel on the Y2001 Front Panel.

3. Obtain an output of 578.5 mV dc from the test dc calibrator.

4. Apply the dc calibrator output to TP1 (HI) and TP18 (LO).

5. Adjust R57 for a thermometer display of 77.0°F.

4-38. TROUBLESHOOTING

4-39. Troubleshooting for the 2190A consists of the tabular flow chart in Table 4-5. When a step on the flow chart is completed check for a decision transfer. If no decision is required perform the next step of the table in sequence.

Table 4-4. Bias Resistor Values

VALUE	JOHN FLUKE PART NUMBER	VALUE	JOHN FLUKE PART NUMBER
49.9k	268821	110k	234708
52.3k	237248	124k	288407
54.9k	271353	140k	289439
57.6k	289116	162k	375998
60.4k	291419	191k	375923
63.4k	235382	237k	288373
68.1k	236828	309k	235283
73.2k	23722	332k	289504
78.7k	289058	464k	271908
84.5k	229492	562k	235358
90.9k	223537	1.05M	260737
100k	248807	∞	OPEN

Table 4-5. 2190A Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
1	Short the thermocouple input.		
2	Set the thermocouple selector switch to position 8 or 9 (Cal. pos.).		
3	Apply power to the thermometer.		
4.	Does the display read 2190.X for ten seconds and then change to 0°C (0°F)? NOTE: X = A numeral depending on the version of software installed.	14	5
5	Does any portion of the display illuminate?	13	6
6	Measure between TP2 and TP4 for +5 ±10% VDC, between TP1 and TP3 for +15 ±5% VDC, and between TP1 and TP2 for -15 ±5% VDC.		
7	Are all voltages correct?	12	8
8	Measure between Pin 8 of T2 and the negative end of C21 for a DC voltage greater than 10.3V and for a peak to peak wave form between Pins 8 and 9 of T2 approximately twice the value of the DC voltage measured at Pin 8.		
9	Are both signals present and correct?	11	10
10	Check the inverter circuit that drives the transformer (T2). Repair as required then resume at Step 3.		
11	Check the transformer secondaries and if any are bad, check the individual regulators and their associated components. NOTE: Analog circuitry may load down the ±15V supplies. Repair as required then resume at Step 3.		
12	Check the +5V path the the Display PCB and the Display PCB Connector. Repair as required then resume at Step 3.		
13	Check the strobes (U4-3, 4, 5, 6, 19) and display seven segment control lines (U4-8, 9, 10, 11, 12, 13, 14). Repair as required then resume at Step 3.		
14	Remove the input short.		
15	Does the display read "0.C."?	17	16
16	Check U14-1, U14-2, U14-13 outputs and their associated components. Repair as required then resume at Step 14.		
17	Set the thermocouple selector switch to the setting of the type thermocouple to be connected in the next step.		
18	Connect a thermocouple to the thermometer and measure some known temperature.		
19	Is the displayed temperature correct?	41	20
20	Does the display read "0.C."?	21	22
21	Check the thermocouple components and the open thermocouple circuit (U14-1, U14-2, U14-13 and their associated components). Repair as required then resume at Step 17.		
22	Can the Calibration Adjustment Procedure be performed?	41	23

Table 4-5. 2190A Troubleshooting (cont)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
23	Are the control signals at U4 pins 26 through 32 toggling between high and low logic levels? NOTE: The INT 3 signal at pin 28 of U4 will remain low (0V) unless the multipoint selector accessory (Y2001) is connected. (Use TP2 as common.)	25	24
24	Replace the microprocessor U4 then resume at Step 17.		
25	Are the outputs of U3 and TP14 toggling between high and low logic levels? NOTE: The output at pin 9 of U3 will remain low (0V) unless the multipoint selector accessory (Y2001) is connected.	27	26
26	Check U3, Q4 and their associated components. Repair as required then resume at Step 17.		
27	Is the waveform at TP7 as shown in Figure 3-2 (Magnitude & Polarity varies with the input signal)?	34	28
28	Is there-6.2 Vdc at TP16. (Use TP1 as common.)	30	29
29	Check the Reference Circuit providing an input at U7-3 from the divider R18, R19, R17, R20, and VR1. Repair as required and resume at Step 17.		
30	Check from TP1 (analog ground) to U9-6 for 100 mV dc and for 200 mV dc at U9-9.		
31	Are both voltages present?	33	32
32	Check Q11, Q12, Q13 and associated components. Reapir as required then resume at Step 17.		
33	Check the Thermocouple Input PCB plus U8-1, Q14, Q15, Q17, and their associated components. Repair as required then resume at Step 17.		
34	Is the waveform at U8-7 as shown in Figure 3-2 (Magnitude & Polarity varies with the input signal)?	38	35
35	Check the operation of Q7, Q8, Q9, Q10, U8 and their associated components. If any defective components are found, repair as required and resume at Step 13. If none are found proceed to the next step.		
36	Connect TP2 and TP5 with a jumper to lock the insturment in the Auto Zero period.		
37	Check U8, U2, U6 and their associated components. This circuit should now function as a closed loop amplifier. Repair as required. Remove the jumper between TP2 and TP5 and resume at Step 17.		
38	Does TP10 toggle between the high and low logic levels?	40	39
39	Check U1 and its associated components then resume at Step 17.		
40	Replace the microprocessor U4, then resume at Step 17.		
41	Troubleshooting of the 2190A is complete. Remove all test equipment, reconnect any cables removed and close the instrument.		

Section 5
List of Replaceable Parts

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A3 Thermocouple Input PCB Assembly	5-4.	5-13	5-4.	5-13

5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown of the instrument. Components are listed alpha-numerically by assembly. Electrical components are listed by reference designation and mechanical components are listed by item number. Each listed part is shown in accompanying illustration.

5-3. Parts lists include the following information:

a. Reference Designation or Item Number.

b. Description of each part.

c. Fluke Stock Number.

d. Federal Supply Code for Manufacturers. (See Section 7 for Code-to-Names list.)

e. Manufacturer's part Number or Type.

f. Total Quantity per assembly or component.

g. Recommended Quantity: This entry indicates the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one in each assembly in the instrument be stocked. In the case of optional subassemblies, plub-ins, etc, that are not always part of the instrument, or are deviations from the basic instrument mode, the REC QTY column lists the recommended quantity of the item in that particular assembly.

h. Use Code: Any character in this column refers to a footnote at the end of the table that begins with the same character.

5-4. HOW TO OBTAIN PARTS

5-5. Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. factory or authorized representative by using the FLUKE STOCK NUMBER. In the event the part you order has been replaced by a new or improved part, the replacement will be acoompanied by an explanatory note and installation instructions, if necessary.

5-6. To ensure prompt and efficient handling of your order, include the following information.

a. Quantity

b. FLUKE Stock Number

c. Description

d. Reference Designation or Item Number.

e. Printed Circuit Board Part number and Revision Letter

f. Instrument Model and Serial Number

Table 5-1. Final Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A1	MAIN PCB ASSY	469395	89536	469395	1		
A2	DISPLAY PCB ASSY	464479	89536	464479	1		
A3	THERMOCOUPLE INPUT PCB ASSY	464461	89536	464461	1		
F1-120	FUSE, FAST ACTING	196790	71400	AGC1-8	1	5	1
F1-240	FUSE, FAST ACTING	109348	71400	AGC1-16	1	5	1
F2	FUSE, SLOW ACTING	109256	71400	MDL3-4	1	5	
H1	SCREW, FHP, CNTRSUNK, 6-32 X 5/8	114876	89536	114876	4		
H2	SCREW, FHP, 82 DEGREES COUNTERSUNK	335158	89536	335158	2		
H3	SCREW, PH, 6-20 X 3/8	288266	89536	288266	1		
H4	SCREW, PHP 4-40 X 1/4	256156	89536	256156	3		
H5	SCREW, PHP, 4-40 X 3/8	256164	89536	256164	2		
H6	SCREW, FHP, 82 DEGREES COUNTERSUNK	256024	89536	256024	1		
HB1	INSTRUCTION MANUAL, 2190A	489229	89536	489229	1		
MP1	DECAL, RETAINER	473645	89536	473645	2		
MP2	HANDLE	454751	89536	454751	1		
MP3	RETAINER, HANDLE	467563	89536	467563	2		
MP4	GUARD, COVER, C-SIZE	464115	89536	464115	1		
MP5	COVER, C-SIZE	454736	89536	454736	1		
MP8	GUARD, BASE	464404	89536	464404	1		
MP9	REAR PANEL	464149	89536	464149	1		
MP10	OUTPUT OPTION COVER	464412	89536	464412	1		
MP11	LIMITS COVER	464156	89536	464156	1		
MP12	LATCH	467548	89536	467548	2		
MP13	BAIL	467555	89536	467555	1		
MP14	FOOT, NON-SKID	467571	89536	467571	4		
MP15	DECAL, REAR PANEL	454645	89536	454645	1		
MP16	FRONT PANEL	472282	89536	472282	1		
MP17	CALIBRATION COVER	471490	89536	471490	1		
MP18	DECAL, BOTTOM	473629	89536	473629	1		
MP19	DECAL, BASE SIDES	473652	89536	473652	2		
MP20	DECA, FRONT PANEL	453233	89536	453233	1		
MP21	CARD GUIDE	464164	89536	464164	2		
U4-JKESR	IC, MICROCOMPUTER, PROGRAMMED	473371	89536	473371	1		2
U4-JKTCR	IC, MICROCOMPUTER, PROGRAMMED	473264	89536	473264	1		2
W1	POWER CORD (NOT SHOWN)	284174	89536	284174	1		
W2	CABLE ASSY	475228	89536	475228	1		
XF-2	FUSE CAP	460238	89536	460238	2		
XF1-1	FUSEHOLDER	375188	89536	375188	2		
XF2-1	FUSEHOLDER	375188	89536	375188	REF		
XF2-2	FUSE CAP	460238	89536	4602238	REF		

1 SELECT FUSE FOR APPLICABLE LINE VOLTAGE

2 SELECT IC FOR THERMOCOUPLE TYPES USED W/ INSTRUMENT

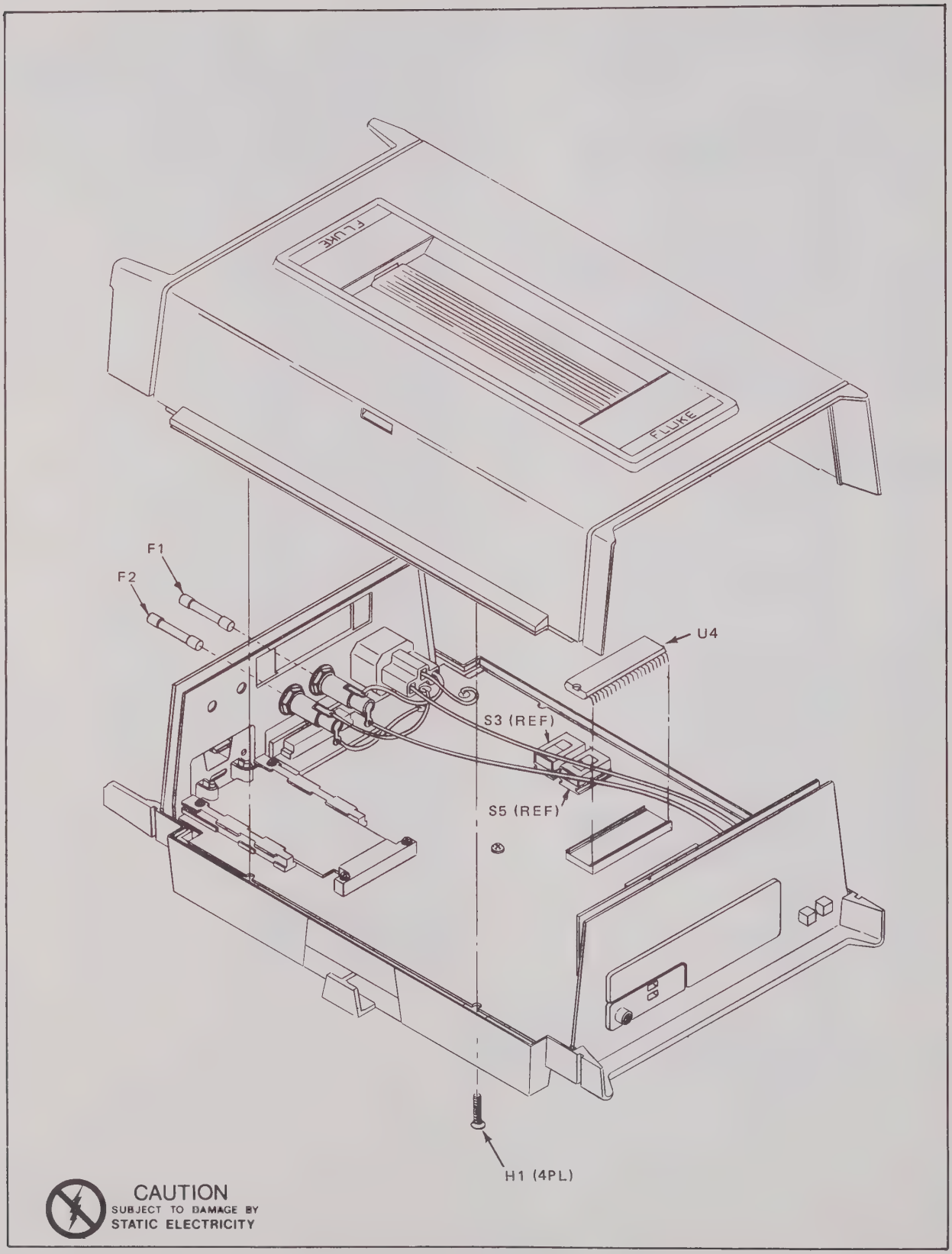


Figure 5-1. Final Assembly

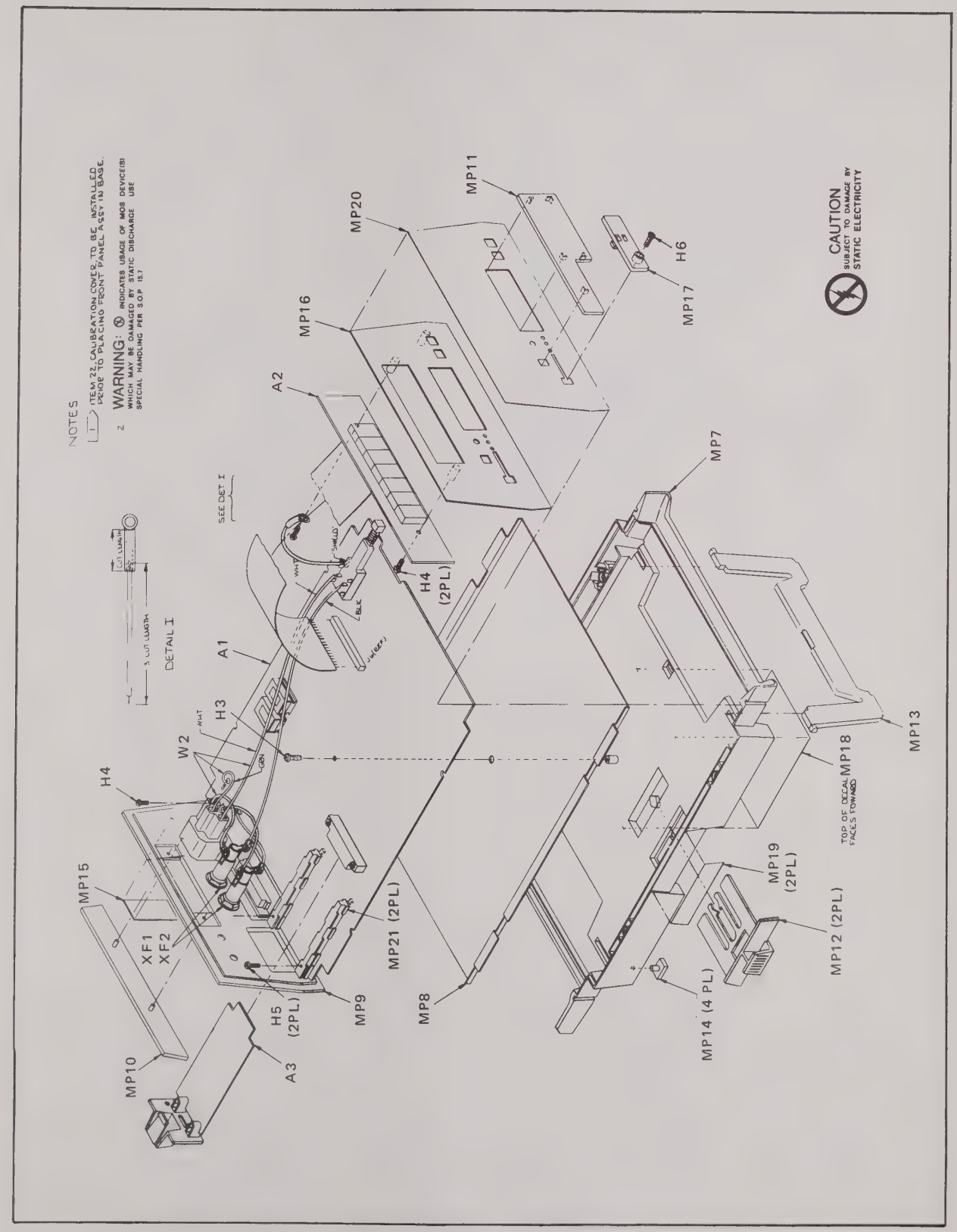


Figure 5-1. Final Assembly (cont)

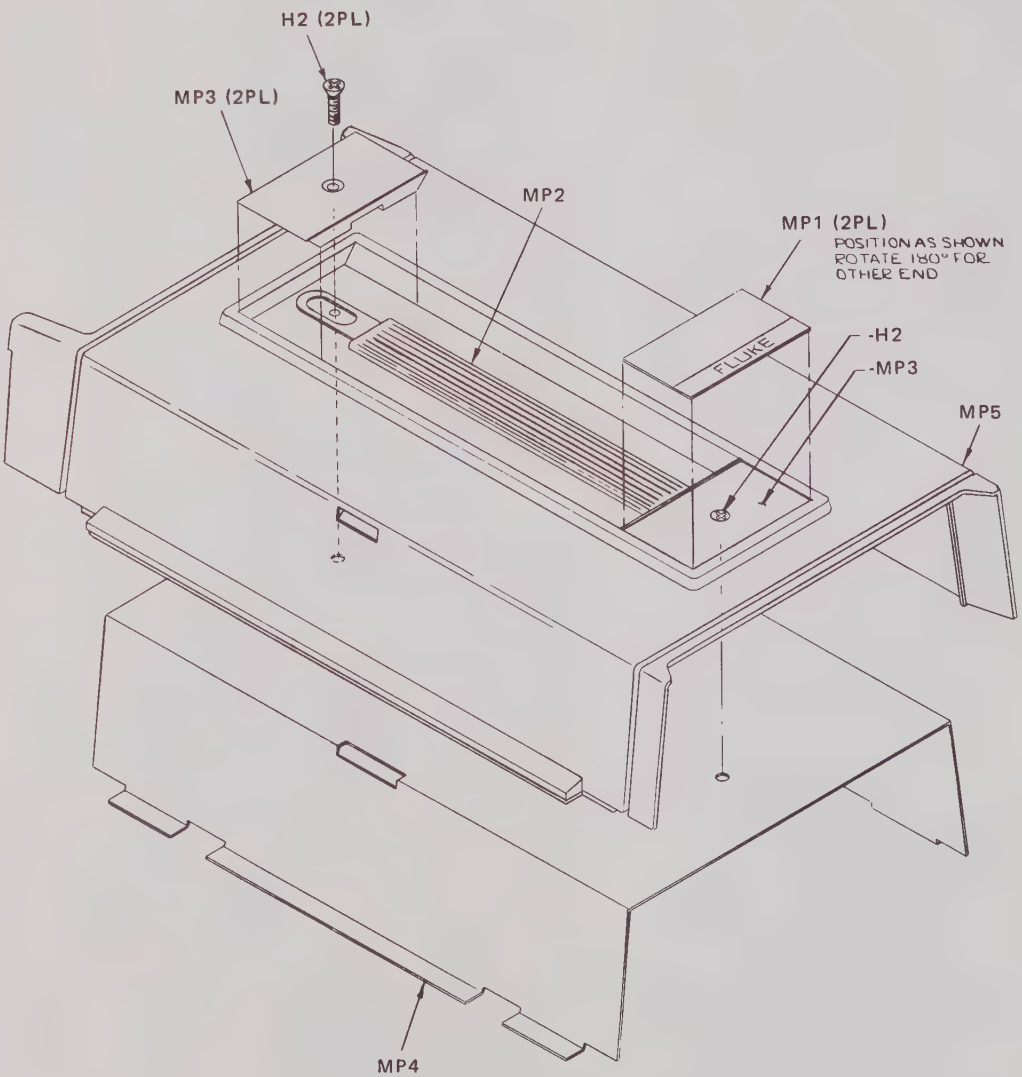


Figure 5-1. Final Assembly (cont)

Table 5-2. A1 Main PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A1	MAIN PCB ASSY (2190A-4001)	469395	89536	469395	REF		
C2	CAP, PLYPRPLN, 0.47 UF +/-5%, 50V	364042	84411	JF78B	1		
C3	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	13		
C4	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C5	CAP, CER, 0.0012 UF +/-10%, 500V	106732	71590	CF122	1		
C6	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C7	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C8	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C9	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C10	CAP, POLLYCARB, 2.2 UF +/-10%, 100V	306522	80031	C280MCH/A2M2	1		
C11	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C12	CAP, MICA, 430 PF +/-5%, 500V	177980	72136	DM15F431J	4		
C13	CAP, MICA, 430 PF +/-5%, 500V	177980	72136	DM15F431J	REF		
C14	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C15	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C16	CAP, MICA, 430 PF +/-5%, 500V	177980	72136	DM15F431J	REF		
C17	CAP, MICA, 430 PF +/-5%, 500V	177980	72136	DM15F431J	REF		
C18	CAP, TA, 10 UF +/-20%, 35V	417683	56289	196D106X0035PE4	1		
C19	CAP, CER, 10,000 PF -20/+80%, 25V	335786	72982	5835-000-Y5U-103Z	2		
C20	CAP, CER, 10,000 PF -20/+80%, 25V	335786	72982	5835-000-Y5U-103Z	REF		
C21	CAP, ELECT, 4000 UF -10/+100%, 25V	370734	80031	3044TS043U025	1		1
C23	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D105X0035JA1	5		
C24	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C25	CAP, TA, 39 UF +/-20%, 20V	358234	56289	196D396X0020PE4	1		
C26	CAP, TA, 22 UF +/-20%, 35V	394775	56289	196D226X0035TE4	2		
C27	CAP, TA, 22 UF +/-20%, 35V	394775	56289	196D226X0035TE4	REF		
C28	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C29	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C30	CAP, POLY, 0.047 UF +/-10%, 250V	162008	73445	C280MAE/A47K	1		
C31	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D105X0035JA1	REF		
C32	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D105X0035JA1	REF		
C33	CAP, TA, 10 UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C34	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D105X0035JA1	REF		
C35	CAP, CER, 0.22 UF	309849	71590	CW30C224K	1		
C36	CAP, TA, 1 UF +/-20%, 35V	161919	56289	196D105X0035JA1	REF		
CR3	RECTIFIER BRIDGE	392910	09423	FB200	1		
CR4	DIOD, SI, HI-SPD SW	203323	07910	1N4448	12		
CR5	DIOD, SI, HI-SPD SW	203323	07910	1N4448	REF		
CR6	DIODE, SI, RECTIFIER	116111	05277	1N4817	1		1
CR7	DIODE	379412	04713	1N4933	2		1
CR8	DIODE	379412	04713	1N4933	REF		
CR9	DIOD, SI, HI-SPD SW	203323	07910	1N4448	REF		
CR10	DIOD, SI, HI-SPD SW	203323	07910	1N4448	REF		
CR12	DIOD, SI, HI-SPD SW	203323	07910	1N4448	REF		
CR13	DIODE FET	348482	89536	348482	2		1
CR14	DIODE FET	348482	89536	348482	REF		
CR15	DIOD, SI, HI-SPD SW	203323	07910	1N4448	REF		
CR16	DIOD, SI, HI-SPD SW	203323	07910	1N4448	REF		
CR17	DIOD, SI, HI-SPD SW	203323	07910	1N4448	REF		
CR18	DIOD, SI, HI-SPD SW	203323	07910	1N4448	REF		

Table 5-2. A1 Main PCB Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
CR19	DIODE, ZENER	393579	04713	1N4567	1	1	
CR20	DIOD, SI, HI-SPD SW	203323	07910	1N4448	REF		
CR21	DIOD, SI, HI-SPD SW	203323	07910	1N4448	REF		
H1	SCREW, PHP, 4-40 X 1/2 (ON T1)	156380	73734	19032	2		
H2	SCREW, PHP, 4-40 X 1/2 (ON J2)	152132	73734	19026	2		
H3	SCREW, PHP, 4-40 X 3/8 (ON J5)152124	73734	19024	2			
H4	LOCKWASHER (ON J5)	110395	89536	110395	2		
H5	WASHER, FLAT (ON J5)	147728	73734	1402	2		
H6	PRESS-NUT (ON J2, J5, T1, PCB)	380196	24347	KF2-440	9		
J1	CONNECTOR	461756	00779	583773-1	1		
J2	CONNECTOR	474007	05574	2VH6/1AKC15	1		
J3	CONNECTOR	448209	00779	1-583773-3	1		
J4	CONNECTOR	484030	00779	1-583773-4	1		
J5	CONNECTOR	461996	00779	206584-1	1		
J6	CONNECTOR	435024	00779	583773-8	1		
K1	RELAY, DRY REED	357582	71707	UF-40070	1		
MP1	BRACKET, SHORTING (BESIDE S1)	487538	89536	487538	1		
Q2	XSTR, FET, N-CHANNEL	343830	89536	343580	8	2	
Q3	XSTR, FET, N-CHANNEL	343830	89536	343580	REF		
Q4	XSTR, SI, NPN	218396	89536	218396	4	1	
Q5	XSTR, SI, NPN	218396	89536	218396	REF		
Q6	XSTR, FET, N-CHANNEL	376475	89536	376475	6	2	
Q7	XSTR, FET, DUAL N-CHANNEL	419283	89536	419283	1	1	
Q8	XSTR, FET, N-CHANNEL	376475	89536	376475	REF		
Q9	XSTR, FET, N-CHANNEL	343830	89536	343580	REF		
Q10	XSTR, FET, N-CHANNEL	429977	89536	429977	1	1	
Q11	XSTR, FET, N-CHANNEL	376475	89536	376475	REF		
Q12	XSTR, FET, N-CHANNEL	376475	89536	376475	REF		
Q13	XSTR, FET, N-CHANNEL	376475	89536	376475	REF		
Q14	XSTR	476911	78425	476911	1	1	
Q15	XSTR, FET, N-CHANNEL	376475	89536	376475	REF		
Q16	XSTR, FET, N-CHANNEL	343830	89536	343580	REF		
Q17	XSTR, FET, N-CHANNEL	343830	89536	343580	REF		
Q18	XSTR, FET, N-CHANNEL	343830	89536	343580	REF		
Q19	XSTR, SI, NPN, PWR	477331	04713	MDS01A	2	1	
Q20	XSTR, SI, NPN, PWR	477331	04713	MDS01A	REF		
Q21	XSTR, SI, NPN	218396	89536	218396	REF		
Q22	XSTR, SI, PNP, PWR	473207	01295	TIP30	1	1	
Q23	XSTR, SI, NPN	218396	89536	218396	REF		
Q24	XSTR, FET, N-CHANNEL	343830	89536	343580	REF		
Q25	XSTR, FET, N-CHANNEL	343830	89536	343580	REF		
R1	RES, SET (R1 & R2)	479030	89536	479030	2	1	
R2	RES, SET (R1 & R2)	479030	89536	479030	REF		
R3	RES, SET (R3 & R4)	479030	89536	479030	2	1	
R4	RES, SET (R3 & R4)	479030	89536	479030	REF		
R5	RES, VAR, 200 +/-10%, 1/2W	275743	89536	275743	2	1	
R6	RES, DEPCAR, 1K +/-5%, 1/4W	343426	80031	CR251-4-5P1KT	1		
R7	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	5		
R8	RES, DEP CAR, 3.3K +/-5%, 1/4W	348813	80031	CR251-4-5P3K3T	2		
R9	RES, DEP CAR, 43K +/-5%, 1/4W	442418	80031	CR251-4-5P43KT	1		

Table 5-2. A1 Main PCB Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R10	RES, DEP CAR, 27K +/-5%, 1/4W	441501	80031	CR251-4-5P27KT	1		
R11	RES, MTL FILM, 10.02K +/-0.1%, 1/8W	352245	89536	352245	4		
R12	RES, MTL FILM, 10.02K +/-0.1%, 1/8W	352245	89536	352245	REF		
R13	RES, MTL FILM, 1K +/-1%, 1/8W	168229	91637	CMF551001F	1		
R14	RES, VAR, 100L +/-10%, 1/2W	369520	89536	369520	1	1	
R15	RES, MTL FILM, 49.9 +/-1%. 1/8W	305896	91637	CMF5549R9F	1		
R16	RES, MTL FILM, 169K +/-1%, 1/8W	289454	91637	CMF551693F	1		
R17	RES, VAR, 500 +/-10%, 1/2W	325613	89536	325613	1	1	
R18	SET, ZENER, REF (VR1, R18, R19)	377283	89536	377283	REF		
R19	SET, ZENER, REF (VR1, R18, R19)	377283	89536	377283	REF		
R20	RES, MTL, FILM, 61.9K +/-1%, 1/8W	237230	91637	CMF556192F	1		
R21	RES, MTL FILM 215K +/-1%, 1/8W	289470	94637	CMF552153F	1		
R22	RES, DEP CAR, 12K +/-5%, 1/4W	348847	80031	CR251-4-5P12KT	1		
R23	RES, MTL FILM, 22.1K +/-1%, 1/8W	235234	91637	CMF552212F	1		
R24	RES, MTL FILM, 221 +/-1%, 1/8W	340794	91637	CMF552210F	1		
R25	RES, MTL FILM, 100 +/-0.1%, 1/8W	357400	91637	CMF551000B	1		
R26	RES, MTL FILM, 10.02K +/-0.1%, 1/8W	352245	89536	352245	REF		
R27	RES, MTL FILM, 10.02K +/-0.1%, 1/8W	352245	89536	352245	REF		
R28	RES, MTL FILM, 200 +/-0.1%, 1/8W	474262	91637	CMF552000B	1		
R29	RES, VAR, 1K +/-20%, 1/2W	267856	75378	190C102B	2	1	
R30	RES, VAR, 1K +/-20%, 1/2W	267856	75378	190C102B	REF		
R31	RES, VAR, 20K +/-20%, 1/2W	267898	75378	109PC203B	1	1	
R32	RES, MTL FILM, 10 +/-10%, 1/8W	268789	91637	CMF55R100F	1		
R33	RES, COMP, 22M +/-5%, 1/4W	221986	01121	CB2265	1		
R34	RES, DEP CAR, 3.3K +/-5%, 1/4W	348813	80031	CR251-4-5P3K3T	REF		
R35	RES, DEP CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330ET	2		
R37	RES, DEP CAR, 100 +/-5%, 1/4W	348771	80031	CR251-4-5P100ET	1		
R38	RES, MTL FILM, 9.09K +/-1%, 1/8W	221663	91637	CMF559091F	1		
R39	RES, MTL FILM, 1.02K +/-1%, 1/8W	223545	91637	CMF551021F	1		
R40	RES, MTL FILM, 4.32K +/-1%, 1/8W	294819	91637	CMF554321F	1		
R41	RES, MTL FILM, 10L +/-1%, 1/8W	168260	91637	CMF551002F	1		
R43	RES, COMP, 16K +/-5%, 1/4W	221606	01121	CB1635	1		
R44	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R45	RES, DEP CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100KT	3		
R46	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R47	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R48	RES, MTL FILM, 150K +/-1%, 1/8W	241083	91637	CMF551503F	1		
R49	RES, MTL FILM, 681K +/-1%, 1/8W	381517	91637	CMF556813F	1		
R50	RES, DEP CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47KT	1		
R51	RES, MTL FILM, 38.3K +/-1%, 1/8W	241372	91637	CMF553832F	1		
R52	RES, MTL FILM, 133K +/-1%, 1/8W	289074	91637	CMF551333F	1		
R53	RES, DEP CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100KT	REF		
R54	RES, DEP CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100KT	REF		
R55	RES, DEP CAR, 5.1K +/-5%, 1/4W	368712	80031	CR251-4-5P5K1T	1		
R56	RES, MTL FILM, 10.2K +/-15, 1/8W	293605	91637	CMF551022F	1		
R57	RES, VAR, 200 +/-10%, 1/2W	275743	89536	275743	REF		
R58	RES, DEP CAR, 51K +/-5%, 1/4W	376434	80031	CR251-4-5P51KT	1		
R59	RES, DEP CAR, 39K +/-5%, 1/4W	442400	80031	CR251-4-5P39KT	2		
R60	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R61	RES, DEP CAR, 470K +/-5%, 1/4W	342634	80031	CR251-4-5P470KT	2		

Table 5-2. A1 Main PCB Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R62	RES, DEP CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7T	2		
R63	RES, DEP CAR, 470K +/-5%, 1/4W	342634	80031	CR251-4-5P470KT	REF		
R64	RES, DEP CAR, 4.7K +/-5%, 1/4W	348821	80031	CR251-4-5P4K7T	REF		
R65	RES, MTL FILM, 309K +/-1%, 1/8W	235283	91637	CMF553093F	1		
R66	RES, DEP CAR, 39K +/-5%, 1/4W	442400	80031	CR251-4-5P39KT	REF		
R67	RES, MTL FILM, 100K +/-1%, 1/8W	248807	91637	CMF551003F	1		
R68	RES, MTL FILM, 64.9K +/-1%, 1/8W	288530	91637	CMF556492F	1		
R69	RES, MTL FILM, 226K +/-1%, 1/8W	320879	91637	CMF552263F	1		
R70	RES, DEP CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330ET	REF		
S1-1	SWITCH	473355	89536	473355	1		
S1-2	BUTTON	445197	89536	445197	1		
S2-1	SWITCH	473454	89536	473454	1		
S2-2	BUTTON	425900	89536	425900	1		
S3	SWITCH	234278	82389	XW1649	2		
S4	SWITCH	423129	89536	423129	1		
S5	SWITCH	234278	82389	XW1649	REF		
T1	XFMR, PWR	464370	89536	464370	1		
T2	XFMR, INVERTER	461954	89536	461954	1		
TB1	TERMINAL BLOCK	479006	89536	479006	2		
TB2	TERMINAL BLOCK	479006	89536	479006	REF		
U1	IC, VOLTAGE COMPARATOR	352195	12040	LM311CN	1	1	
U2	IC, LINEAR OP-AMP	429837	12040	LF356H	1	1	
U3	IC, CMOS, HEX, OPEN DRAIN BUFFERS	473389	12040	MM74C906N	1	1	
U4	SEE FINAL ASSEMBLY						
U5	RES, NETWORK, 47K	413286	89536	413286	1	1	
U6	IC, LINEAR, OP-AMP	472779	12040	LF356N	1	1	
U7	IC, LINEAR, OP-AMP	413740	12040	LM307N	1	1	
U8	IC, LINEAR, DUAL OP-AMP	478032	04713	MC4558NCP1	1	1	
U9	RES, NETWORK	448480	89536	448480	1	1	
U10	IC, LINEAR, OP-AMP	418566	12040	LM358N	1	1	
U11	IC, LINEAR, NEG VOL REG	413179	12040	LM340T-15	1	1	
U12	IC, LINEAR, VOL REF, RCD	413187	12040	402644	1	1	
U13	RES, NETWORK	402644	89536	402644	1	1	
U14	IC, LINEAR, QUAD, COMPARATOR	387233	12040	LM339N	1	1	
VR1	SET, ZENER, REF (VR1, R18, R19)	377283	89536	377283	1	1	
VR2	DIODE, ZENER	186163	07910	1N974B	2	1	
VR3	DIODE, ZENER	186163	07910	1N974B	REF		
XQ22	HEATSINK	473785	13103	6046PB	1		
XU4	SOCKET, IC, 40-PIN	418988	91506	340-AG39D	1		
Y1	XTAL, QUARTZ	474072	89536	474072	1	1	

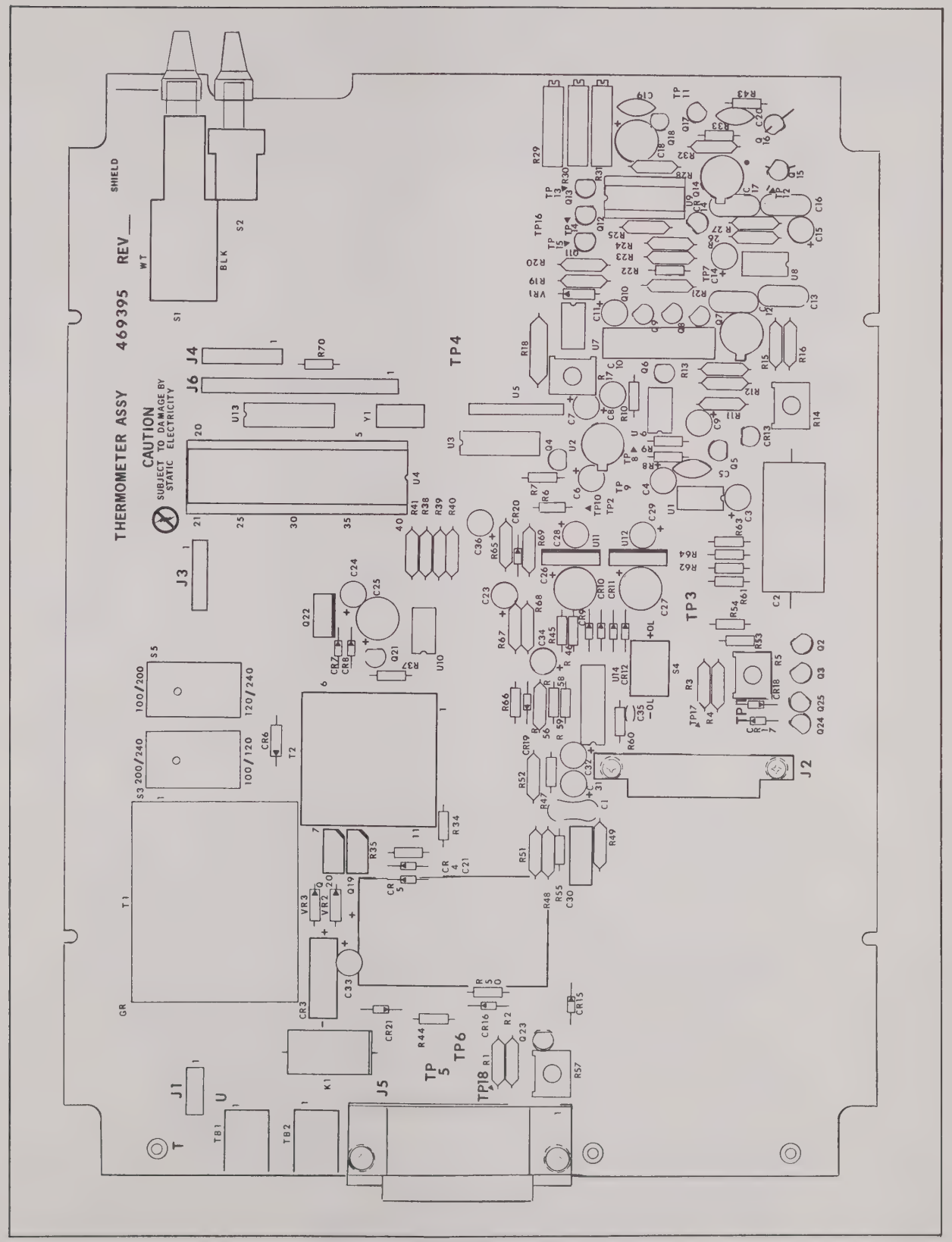


Figure 5-2. A1 Main PCB Assembly

Table 5-3. A2 Display PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A2	DISPLAY PCB ASSY (2190A-4002)	464479	89536	464479	REF		
DS1	DISPLAY, LED	418012	28480	5082-7651	6	2	
DS2	DISPLAY, LED	418012	28480	5082-7651	REF		
DS3	DISPLAY, LED	418012	28480	5082-7651	REF		
DS4	DISPLAY, LED	418012	28480	5082-7651	REF		
DS5	DISPLAY, LED	418012	28480	5082-7651	REF		
DS7	DISPLAY, LED	418012	28480	5082-7651	REF		
P1	DECAL	477042	89536	477042	1		
P6	CABLE, JUMPER	474411	00779	1-86947-7	1		
Q1	XSTR, SI, PNP	195974	89536	195974	13	3	
Q2	XSTR, SI, PNP	195974	89536	195974	REF		
Q3	XSTR, SI, PNP	195974	89536	195974	REF		
Q4	XSTR, SI, PNP	195974	89536	195974	REF		
Q5	XSTR, SI, PNP	195974	89536	195974	REF		
Q6	XSTR, SI, PNP	195974	89536	195974	REF		
Q7	XSTR, SI, PNP	195974	89536	195974	REF		
Q8	XSTR, SI, PNP	195974	89536	195974	REF		
Q9	XSTR, SI, PNP	195974	89536	195974	REF		
Q10	XSTR, SI, PNP	195974	89536	195974	REF		
Q11	XSTR, SI, PNP	195974	89536	195974	REF		
Q12	XSTR, SI, PNP	195974	89536	195974	REF		
Q13	XSTR, SI, PNP	195974	89536	195974	REF		
R1	RES, DEP CAR, 100 +/-5%, 1/4W	348771	80031	CR251-4-5P100ET	2		
R2	RES, DEP CAR, 100 +/-5%, 1/4W	348771	80031	CR251-4-5P100ET	REF		
U1	IC, LINEAR, NPN 5-XSTR ARRAY	418574	02735	CA3083E	1	1	
U2	RES, NETWORK	407445	89536	407445	1	1	
U3	RES, NETWORK	478859	89536	478859	1	1	

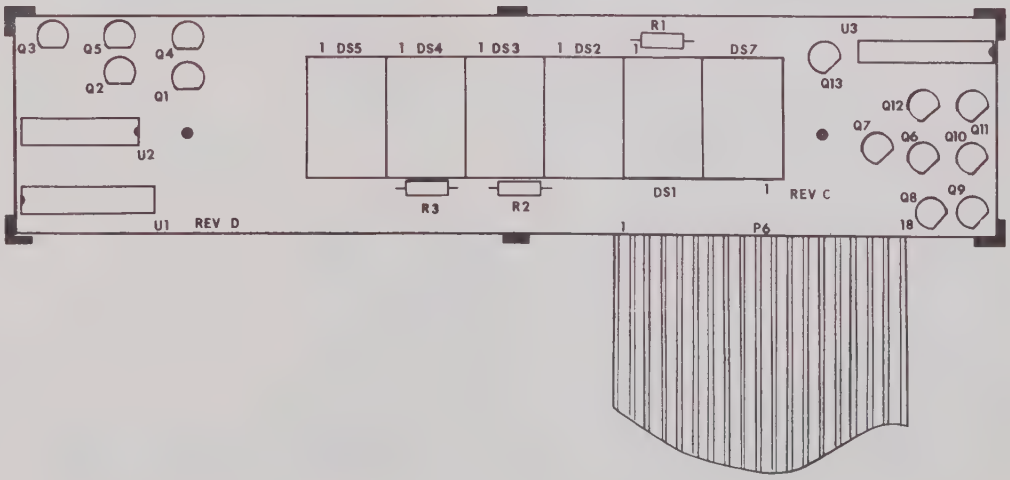


Figure 5-3. A2 Display PCB Assembly

Table 5-4. A3 Thermocouple Input PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A3	THERMCOUPLE INPUT PCB ASSY (2190A-4003)	464461	89536	464461	REF		
C1	CAP, POLY CARB, 2.2 UF +/-10%, 100V	306522	80031	C280MCH/A2M2	1		
C2	CAP, MICA, 100 PF +/-5%, 500V	148494	72136	DM15F101J	1		
H1	SCREW, PHP, 6-32 X 1/4	152140	73734	19042	2		
H2	SCREW, SEMS (ON MP1, MP5)	281196	89536	281196	4		
H3	P-NUT (ON MP1)	380196	24347	KF2-440	2		
MP1	INPUT DRAWER	464123	89536	464123	1		
MP3	POS TC IN	472381	89536	472381	1		
MP4	NEG TC IN	472399	89536	472399	1		
MP5	INISULATOR	473561	89536	473561	1		
Q1	XSTR, SI, NPN	329698	12040	SM07042	1	1	
R1	RES, VAR, 50 K +/-10%, 1/2W	330688	75378	190PC503B	1	1	
R2	RES, MTL FILM, 187K +/-1%, 1/8W	291641	91637	CMF551873F	1		
R4	RES, COMP, 47K +/-10%, 2W	110015	01121	HB4731	1		
S1	SWITCH, MODULE	408559	00779	435166-2	1		

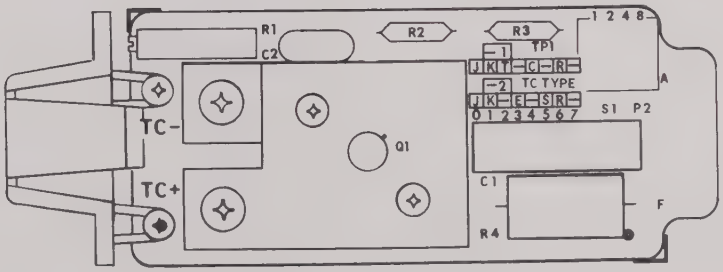


Figure 5-4. A3 Thermocouple Input PCB Assembly

Section 6
Option & Accessory Information

6-1. INTRODUCTION

6-2. This section of the manual contains information on the accessories and options available for the 2190A Digital Thermometer.

6-3. ACCESSORY INFORMATION

6-4. The portion of this section dealing with accessories contains the details of all accessories available for the 2190A.

6-5. OPTION INFORMATION

6-6. Each of the options available for the 2190A are described separately in a sub-section identified with the option name and number. The option description contains the information on the operating instructions and maintenance not covered in the main body of the text plus a complete list of repaceable parts for the option.

TABLE OF CONTENTS

OPTION/MODEL NO.	DESCRIPTION	PAGE NO.
	ACCESSORIES	600-1
21X0-002	Output Option	602-1
21X0-006	Limits Option	606-1

Accessories

600-1. GENERAL

600-2. Table 600-1, contains a list of the accessories available for use with the 2190A Digital Thermometer. The following paragraphs contain information on the types of accessories. Instructions for use accompany each accessory. In all cases order using the accessory number listed.

Table 600-1. 2190A Accessories

ACCESSORIES	DESCRIPTION
Y2001	Multipoint Selector, Thermocouple
Y2002	Alarms Output
Y2003	Calibrator, Thermocouple Indicator
Y2009	Battery Pack, 12V Rechargeable
Y2010	Rack Panel PTI, single, A size (for Y2001)
Y2011	Rack Panel PTI, double, A size (for Y2001)
Y2012	Rack Panel PTI, single, B size (for Y2003 and Y2009)
Y2013	Rack Panel PTI, double, B size (for Y2003 and Y2009)
Y2014	Rack Panel PTI, single, C size (for 2190A, Y2002 and Y2023)
Y2015	Rack Panel PTI, double, C size (for 2190A, Y2002 and Y2023)
Y2018	Panel Mount PTI-DIN, A size (for Y2001)
Y2019	Panel Mount PTI-DIN, B size (for Y2003 and Y2009)
Y2020	Panel Mount PTI-DIN, C size (for 2190A, Y2002 and Y2023)
Y2022	Divider, Thermometer Calibrator
Y2023	Accessory Case
Y2024	Power Cord, 3-way
P20J	J-Type Thermocouple Probe
P20K	K-Type Thermocouple Probe
P20T	T-Type Thermocouple Probe
P20E	E-Type Thermocouple Probe

600-3. MULTIPOINT SELECTOR, THERMOCOUPLE (Y2001)

600-4. The multipoint selector allows the operator to manually select and monitor one of up to ten channels. Two separate thermocouple types (maximum of five each if two types used) may be connected to the unit. Up to ten multipoint selectors may be connected in series.

600-5. ALARMS OUTPUT (Y2002)

600-6. The Alarms Output accessory provides controls to permit up to four separate limit settings, so that there is an operator indication at more than one temperature point. The four thumbwheel controls allow the simultaneous setting of a high and low in any combination.

600-7. CALIBRATOR, THERMOCOUPLE INDICATOR (Y2003)

600-8. This accessory, when used in conjunction with the 2190A provides a variable output for calibration of less sensitive thermocouple devices than the 2190A. The 2190A display is controlled by the calibrator millivolt output (–10 to +90 mV dc) and the less sensitive thermometer may be adjusted to the 2190A displayed temperature. The Y2003 can perform remote calibrations using its self-contained battery pack as a source and can supply external power to the thermometer from this battery pack.

600-9. BATTERY PACK, 12V RECHARGEABLE (Y2009)

600-10. The rechargeable battery pack provides the 2190A and its accessories with portability. The output is +12V dc at a maximum of 750 mA for a total of 2.2 ampere-hours.

600-11. DIVIDER, THERMOMETER CALIBRATION (Y2022)

600-12. The device is a preset 100 to 1 divider to provide the precision millivolt outputs from a DC Calibrator required for calibration. The device plugs into the instrument in place of the Thermocouple Input PCB Assy when used during calibration.

600-13. RACK PANELS

600-14. Available are rack mounting panels in three sizes and two types for the standard 19-inch electronics equipment racks. The "A" size for the multipoint selector is available in panels that will accomodate either one or two instruments. The "B" size panel for the Calibrator and/or Battery Pack is also available for single or double instruments, as is the "C" size used for the 2190A Thermometer and the Alarms Output.

600-15. PANEL MOUNTS

600-16. The panel mounts provide the hardware to install the instrument in any panel in which a hole the size of the instrument front panel can be cut. It is available for the three instrument sizes required, "A", "B", and "C".

600-17. THERMOCOUPLE PROBES

600-18. Thermocouple probes are available from the John Fluke Mfg. Co., Inc., for the J, K, T, and E thermocouple types.

600-19. ACCESSORY CASE (Y2023)

600-20. The accessory case is a "C" sized PTI case which contains a storage drawer. This provides the operator that has several instruments in a stacked group storage space for test equipment and spare and/or alternate thermocouple probes and wires.

600-21. POWER CORD, 3-WAY (Y2024)

600-22. This accessory is a specially constructed power cord with three female and one male connectors that allow the operator to connect up to three "C" size or smaller PTI instruments with one line power cord.

Option -002
Output

602-1. INTRODUCTION

602-2. The 21X0-002 Option is an analog and digital output unit. It provides either the 2180A or 2190A Model Thermometers with a recording output for a permanent record, when required. The option may be ordered with the unit for factory installation or is available as a kit for installation in the field.

602-3. The analog output is available on the rear panel at two flush banana jacks with the polarity indicated. The output is a scaled voltage source of 1 millivolt per degree of temperature, regardless of the temperature scale selected, with the polarity as read on the display. For example; a reading of 251°F would output +251 mV dc, 97.3°C would output +97.3 mV dc, and -31.9°F would output -31.9 mV dc.

602-4. The digital output is a clocked message that can be in two different formats to match the requirements of the customer's equipment. Output on one set of lines is a bit parallel, byte serial message format designed for printer interface. Also available are the standard EIA RS232C and current loop bit serial outputs. Both formats provide the channel number, the current reading displayed, and any out of range or open thermocouple information.

602-5. SPECIFICATIONS

602-6. Specifications for the Output Option, 21X0-002 are as listed in Table 602-1.

Table 602-1. Specifications

Analog Output

Type: Linearized and isolated.
Voltage: 1.0 mV/ °C or °F from -425 mV to 4.5V, 5 mA max.
Temperature Coefficient: 200 ppm/ °C from 25°C.
Noise: ≤100 uV at 100 Hz bandwidth.
Accuracy: ±0.1% of reading ±1 mV.
Zero Drift: 200 uV/°C from 25°C,
Warm-Up Time: 20 minutes, to rated accuracy.

Digital Output

Types: Three, E.I.A. Standard RS-232-C Type 2, TTY current loop, and parallel ASCII.
Connector: 36-pin AMP "Champ".
Serial Baud Rates: 110, 150, 300, 600, 1200, 2400, 4800, 9600, switch-selectable.
RS-232-C Signals: Transmitted Data, Request to Send, Clear to Send, Data Set Ready, Signal Common.
Parallel ASCII Signals: Data 8 lines, instrument address 3 lines, Address Valid, Data Valid, Acknowledge, ground, +5V.
Parallel ASCII Data Rate: Three readings per second.
Parallel ASCII Interface: Plug-to-plug compatible with similar Fluke equipment.
TTY Current Loop Signals: Source and controlled sink, 20 mA.
Out-of-Limit Signal: Exclamation point transmitted with Option 21X0-006 only; not with Y2002.
Battery Operation: 4 to 5 hours typical at 25°C on fully charged Y2003 or Y2009.

602-7. INSTALLATION

602-8. Options for field installation can be installed using the following procedure:

1. Disconnect the thermometer from all input power sources.
2. Remove the screws on the bottom of the case that fasten the top and bottom of the PTI case together and remove the top half of the case.
3. Remove the center mouting screw that attaches the Main PCB to the case and lift the PCB clear of the case.
4. Attach the four spacers supplied with the option to the component side of the pcb in the holes forming a rough rectangular pattern (do not use the fifth hole on the corner, next to U1).
5. Reinstall the Main PCB in the bottom half of the case.

Table 602-2. Switch Selection

SWITCH POSITION	SWITCH BANK 1	2	3	4	S1 BAUD RATE	S2 FUNCTION	S3 ADDRESS
0	OFF	OFF	OFF	OFF	110	OPERATE	ADR 0
1	ON	OFF	OFF	OFF	150	CAL 1	ADR 1
2	OFF	ON	OFF	OFF	300	CAL 2	ADR 2
3	ON	ON	OFF	OFF	600	CAL 3	ADR 3
4	OFF	OFF	ON	OFF	1200	CAL 4	ADR 4
5	ON	OFF	ON	OFF	2400	CAL 1	ADR 5
6	OFF	ON	ON	OFF	4800	CAL 2	ADR 6
7	ON	ON	ON	OFF	9600	CAL 3	ADR 7
8	OFF	OFF	OFF	ON	110	PLOT 1	ADR 8
9	ON	OFF	OFF	ON	150	PLOT 2	ADR 9

6. On the Output Unit PCB use Table 602-2 and S1 to select the desired BAUD rate, select position 0 on the Function Switch S2, and select the PTI Bus Address using S3.

7. Connect the Output Unit cables to the connectors on the Main PCB.

8. Attach the Output Unit PCB to the spacers, component side down and the connector to the rear panel access port.

9. Replace the PTI cover on the instrument and reconnect the input power sources, if required at this time.

602-9. OUTPUT CONNECTIONS

602-10. All connections between the Output Unit Option and External instruments are made using the rear panel connectors previously described. The analog output is from standard banana jacks. The digital output female connector has a mating male connector accompanying the option. This allows the customer to custom make a cable between the thermometer output option and the receiving device. Table 602-3, is the pin-out data for the digital output connector.

602-11. OPERATION

602-12. Once the Output Unit Option is installed the only operator functions deal with the connection of external equipment to the analog or digital output connectors.

602-13. The positive and negative analog terminals have available a dc millivolt output, with the same polarity, and proportional to the temperature displayed. For example, if the thermometer displayed +105.7° F the analog output would be +105.7 mV dc and for –53.1°C the output would be –53.1 mV dc. The full resolution of the temperature display (tenths or hundredths of degrees) is reflected on the output.

602-14. The digital output can be connected to a printer or any device accepting parallel ASCII data, or to a device accepting RS232 or Current Loop signals. Connections for all three types of signals are available simultaneously on the 36-pin output connector previously described.

602-15. THEORY OF OPERATION

602-16. The Output Unit Option converts the temperature displayed by the output into a format usable by the customer's equipment. The output may be available as a scaled analog voltage or as formatted parallel and serial ASCII digital output. The following paragraphs describe operation of the Accessory Bus that handles communication between the instrument and the options, the analog output circuitry, and the digital output circuitry. Refer to the schematic in Section 8 during the following discussion.

Table 602-3. Digital Output Connector Pin-Out

PIN NO.	FUNCTION	MNEMONIC	USE
1	Address Valid	ADRVAL	PTI Bus
2	Data Valid	DATVAL	PTI Bus
3-6	Printer Address	A0-A3	PTI Bus
7	Acknowledge	ACK	PTI Bus
8	Not Used		
9-16	Data	D0-D7	PTI Bus
17	Ground		PTI Bus
18	+5 Volts		PTI Bus
19-24	Not Used		
30	Transmitted Data		RS232 Interface
31	Request to send		RS232 Interface
32	Clear to send		RS232 Interface
33	Data set ready		RS232 Interface
34	Signal Common		RS232 Interface
35	S0+		Current Loop
36	S0–		Current Loop

602-17. Accessory Bus Communication

602-18. The option communicates with the thermometer on the clocked bit serial accessory bus. Transmitted on the bus are channel number, range, conversion type, scale, and digits of the temperature reading. When the $\overline{\text{WRTADR}}$ line is held low, $\overline{\text{DCLK}}$ clocks the address of the Output Unit (4) followed by the thermometer data to the microprocessor on the $\overline{\text{DATA}}$ line. Once into the microprocessor, the data is converted, formatted, and output to the analog and digital output circuitry.

602-19. Analog Circuitry

602-20. The temperature reading received by the microcomputer is used to generate an integrate control signal, the length of which is proportional to the magnitude of the temperature reading. This signal is used to turn on the FET switches Q6, open the switches U11-2, U11-3 and U12-3, and set the output polarity with switches at U12-9 and U12-10. (U12-9 is closed when a negative reading is being processed and U12-10 when a positive signal is being processed.)

602-21. With Q6 on, the capacitor C1 is charged linearily to a voltage proportional to the length of the control signal at Q6. When Q6 has been on for the time required, it is opened, and switch U11-3 is closed, so the output of U13-8 can be sampled and held on C2. After 10 mS switch U11-3 opens and switch U11-11 is closed. To zero the integrate capacitor, C1, until the next conversion cycle.

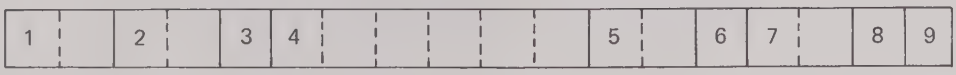
602-22. The voltage held on C2 is buffered by U13-7 U13-14 either passes the voltage directly to the output stage, or amplifies it as controlled by switches U12-9 and U12-10 which alternate states to set the polarity. The output stage at U13-1 has a constant gain of –1.

602-23. Digital Output Circuitry

602-24. The thermometer reading transmitted on the accessory bus every 333 ms is formatted by the microcomputer and, if requested, made available on the PRI Bus, RS232, and current loop outputs. Refer to the schematics in Section 8 during the following description.

602-25. Eight data, four adress, a data valid, an address valid, and an acknowledge line are used by the PTI Bus interface. The external device requests data from the Output Unit by applying the preselected address to the address lines. The address is preselected by setting switch S3 to the desired number (0-9). When the proper address is decoded the tri-state output buffers (U8 and U9) are enable, and the microcomputer and external device notified that the Output Unit has a valid address. When the conversion process is complete, the microcomputer applies the first character of the formatted data to the output lines and pulls the $\overline{\text{DATVAL}}$ line low. The external device reads the Data and pulls the $\overline{\text{ACK}}$ line low, causing the Output Unit to reply with a new character. The process is repeated until data transfer is complete. The message formats are shown in Figure 602-1.

602-26. After transfer to the printer lines is complete, the microprocessor checks the DATA SET



1	Two digit channel number
2	Two blanks
3	Sign – plus or minus
4	Five Digit Numeric with a decimal point for either tenths or hundreds
5	Two character temperature scale. Either °C or °F on PTI Bus and either blank C or blank F on RS232
6	Character "!" when preset limits are exceeded. One blank if signal within limits
7	Two character display – "OL" for overload, "OC" for open circuit or open thermocouple or two blanks if operating normally
8	Carriage return
9	Line Feed

Figure 602-1. Message Format

READY and CLEAR TO SEND lines from the RS232C interface. If both lines are high, the same message as was output on the print lines, is output on the RS232 and current loop lines in a bit serial format. Since the thermometer cycle rate of 333 ms is shorter than the time required to output data at BAUD rates of 1200 and less a message is not transmitted during every instrument cycle.

602-27. Calibration

602-28. Analog circuitry in the option should be calibrated every 90 days or after any repair of the unit. The procedure following assumes that power is supplied to the unit and that a Digital Voltmeter capable of reading 10 μV on the 1 volt, or equivalent range, i.e., a Fluke Model 8800A, is available.

1. Remove power from the instrument.
2. Remove the top cover from the thermometer.
3. Remove the screws attaching the option pcb to the Main PCB.
4. Leaving the interconnect cables connected, turn the option pcb to the right, while facing the instrument, exposing the component side and making the switches and adjustment accessible.
5. Connect the DMM to the Analog Output Connector.
6. Apply power to the instrument and allow it to warm-up for a minimum of 20 minutes.
7. Set the FUNCTION switch (S2) to position 1 (CAL 1).
8. Adjust R26 for an output of 0 $\pm$ 0.1 mV dc.
9. Set the FUNCTION switch to position 2 (CAL 2).
10. Adjust R15 for an output of 0 $\pm$ 0.1 mV dc.
11. Set FUNCTION switch to position 3 (CAL 3).
12. Adjust R11 for an output of –10V $\pm$ 1 mV dc.
13. Set FUNCTION switch to position 4 (CAL 4).
14. Adjust R19 for an output of +10V $\pm$ 1 mV dc.
15. Remove power and the test DMM then reinstall the option pcb on the Main PCB and the top cover on the instrument.

602-29. TROUBLESHOOTING

602-30. Troubleshooting for the 21X0-002, Output Unit, consists of the Tabular flow chart in Table 602-4. When a step on the flow chart is completed, check for a decision transfer. If no decision is required, perform the next step of the table in sequence.

602-31. LIST OF REPLACEABLE PARTS

602-32. Table 602-5 is a list of replaceable parts for the Output Option. Refer to Section 5 for an explanation of the columnar entries.

Table 602-4. Output Option Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
	NOTE *These tests are based on the assumption that the 2180A/2190A has been thoroughly checked out and is free of troubles prior to beginning the test of the Output Option –002.*		
1	Obtain a reading on the 2190A (the input can be shorted for a display of approximately the ambient temperature).		
2	Is the Output option's analog output equal to the 1 mV per degree specified?	16	3
3	From pin 20 (common isolated) on U7 is there +5 volts to pin 40 of U7, +15 volts to pin 4 of U13, and –15 volts to pin 11 of U13?	5	4
4	Check for a 12V dc input at P1 pins 1 and 4, an≈ 20 kHz squarewave from T1 pin 8 to pins 7 and 9, >5.5V at the emitter of Q12, >17.5V at the input of U19, and <17.5V at the input of U20. Repair as required then resume at step 1.		
5	Are the signals at pins 24, 25, and 38 of U7 toggling (vary between a logic high and logic low)?	7	6
6	Check the input, cabling and U1 if all signals are absent. Check the individual line's components if one is absent. Repair as required then resume at step 1.		
7	Are the signals at pins 10 through 15 of U7 toggling?	9	8
8	Check U7 and its clock input from Y1 (4 MHz and opposite in phase from common to pin 1 and 2). Repair as required then resume at step 1.		
9	Are the following signals on U6 as stated: pins 5 and 11 toggling; pins 1 and 3 opposite, and reverse when the output sign is changed; pin 13 low except in CAL 1 position; and pin 9 varying with the length of charge time?	11	10
10	Check U5 and U6. Repair as required then resume at step 1.		
11	Is the signal at the gate of FET switch Q6 toggling between common and –15V?	13	12
12	Check Q14, CR17 and their associated components. Repair as required then resume at step 1.		
13	Perform the Output Option Calibration procedure.		
14	Are all points adjustable within the stated tolerance?	16	15
15	Check the components associated with each adjustment. Since the ICs U11, U12, and U13 are multi-parts units they effect all circuits. Repair as required then resume at step 1.		
16	Obtain a reading and vary the BAUD rate selection switch through its range while observing the output at each BAUD rate setting.		
17	Is the data transmitted correctly at all BAUD rates?	34	18
18	Is the data transmitted correctly at one or more BAUD rates?	19	20
19	Check the BAUD rate selection switch S1. Repair as required then resume at step 16.		
20	Are CLEAR TO SEND (CTS) and DATA SET READY (DSR) at U7-8 and U7-9 respectively at a logic low?	22	21

Table 602-4. Output Option Troubleshooting (cont)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
	NOTE *This is with a receiving device attached. If not attached tie pins 32 and 33 of J7 high to simulate an accepting device.*		
21	Check the interface from the RS232 device, Q8, Q9 and their associated components. Repair as required then resume at step 16.		
22	Is the signal at pin 3 of U7 toggling?	24	23
23	Check U7. Repair as required then resume at step 16.		
24	Does the signal at pin 30 of J7 in reference to pin 34 of J7 toggle while a message is transmitted?	26	25
25	Check Q4, Q5, U18, and their associated components. Repair as required then resume at step 16.		
26	Is the output data available on the PT1 Bus?	26	27
27	Is the signal at U10-6 low?	29	28
28	Verify that the input address and address switch setting are the same. Check the address decoding circuit in U10, U16, U17, U15, U21, S3 and their associated components. Repair as required then resume at step 26.		
29	Is $\overline{\text{ADRVAL}}$ low at pin 1 of J7?	31	30
30	Check the tri-state buffer U8 and it's enabling signal. Repair as required then resume at step 26.		
31	Do the $\overline{\text{DATVAL}}$, $\overline{\text{ACK}}$ and D0 through D7 signals on pins 2, 7, and 9 through 16 of J7 respectively toggle?	33	32
32	Check the tri-state buffers U8 and U9, the microprocessor U7, and the $\overline{\text{ACK}}$ input from the PTI Bus. Since the the RS232 output has already been checked, the input to U7 has been verified. Repair as required then resume at step 26.		
33	Check the connector, interconnecting cable and receiving device. Repair as required then resume at step 26.		
34	Troubleshooting of the Output Option is complete.		

Table 602-5. A4 Output Option PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A4	OUTPUT OPTION PCB ASSY (2180A-4120)	-002	89536	S190A-002	REF		
C1	CAP, POLYSTRN, 0.56UF +/-10%, 100V	284851	89536	284851	1		
C2	CAP, POLYPRPLN, 0.47UF +/-10%, 50V	363085	89536	363085	1		
C3	CAP, CER, 0.22UF +/-20%, 50V	309849	71590	CW30C224K	1		
C4	CAP, TA, 10UF +/-20%, 20V	330662	56289	196D106X0020KA1	8		
C5	CAP, TA, 39UF +/-20%, 20V	358234	56289	196D396X0020PE4	1		
C6	CAP, TA, 10UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C7	CAP, TA, 22UF +/-20%, 35V	394775	56289	196D226X0035TE4	2		
C8	CAP, TA, 22UF +/-20%, 35V	394775	56289	196D226X0035TE4	REF		
C9	CAP, TA, 10UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C10	CAP, TA, 10UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C11	CAP, TA, 10UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C12	CAP, TA, 1UF +/-20%, 35V	161919	56289	196D105X0035JA1	2		
C13	CAP, TA, 10UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C14	CAP, TA, 10UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C15	CAP, TA, 10UF +/-20%, 20V	330662	56289	196D106X0020KA1	REF		
C16	CAP, TA, 1UF +/-20%, 35V	161919	56289	196D105X0035JA1	REF		
C17	CAP, CER, 0.025UF +/-20%, 100V	168435	56289	C023B101H253M	1		
CR1	DIODE, ZENER	393579	07910	1N4567	1	1	
CR3	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	10	2	
CR4	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR5	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR6	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR7	DIODE, ZENER, 36V	186163	07910	1N974B	2	1	
CR8	DIODE, ZENER, 36V	186163	07910	1N974B	REF		
CR9	DIODE, SI, RECT	379412	04713	1N4933	2	1	
CR10	DIODE, SI, RECT	379412	04713	1N4933	REF		
CR11	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR12	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR13	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR14	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR15	DIODE, ZENER, 6.2V	325811	07910	1N752A	1	1	
CR16	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
CR17	DIODE, SI, HI-SPEED SWITCHING	203323	07910	1N4448	REF		
H1	SCREW, PHP, 4-40 X 3/8	152124	73734	19024	2		
H2	WASHER, LOCK	110395	89536	110395	2		
H3	NUT, HEXAGON	147611	89536	147611	2		
J7	CONNECTOR	414409	00779	552241-1	1		
J7-1	CONNECTOR	435750	00779	552565-1	1		
J8	JACK, INPUT	454058	89536	454058	2		
P1	CABLE, JUMPER	474148	00779	86942-3	1		
P3	CABLE, JUMPER	474155	00779	86942-5	1		
Q1	XSTR, SI, NPN	218396	04713	2N3904	8	2	
Q2	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q3	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q4	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q5	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q6	XSTR, FET, N-CHANNEL	429977	89536	429977	1	1	
Q7	XSTR, FET, N-CHANNEL	343830	89536	343830	1	1	
Q8	XSTR, SI, NPN	218396	04713	2N3904	REF		

Table 602-5. A4 Output Option PCB Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
Q9	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q10	XSTR, SI, NPN, PWR	477331	04713	MDS01A	2	1	
Q11	XSTR, SI, NPN, PWR	477331	04713	MDS01A	REF		
Q12	XSTR, SI, PNP, PWR	473207	01295	TIP30	1	1	
Q13	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q14	XSTR, SI, PNP	195974	04713	2N3906	1	1	
R1	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	12		
R2	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R3	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R4	RES, DEP CAR, 220K +/-%, 1/4W	348953	80031	CR251-4-5P220KT	3		
R5	RES, DEP CAR, 2.2K +/-5%, 1/4W	343400	80031	CR251-4-5P2K2T	4		
R6	RES, DEP CAR, 220K +/-%, 1/4W	348953	80031	CR251-4-5P220KT	REF		
R7	RES, DEP CAR, 2.2K +/-5%, 1/4W	343400	80031	CR251-4-5P2K2T	REF		
R8	RES, DEP CAR, 220K +/-%, 1/4W	348953	80031	CR251-4-5P220KT	REF		
R9	RES, DEP CAR, 2.2K +/-5%, 1/4W	343400	80031	CR251-4-5P2K2T	REF		
R10	RES, MF, 16.9K +/-1%, 1/8W	267146	91637	CMF551692F	1		
R11	RES, VAR, 25K +/-20%, 1/2W	285213	75378	190PC253B	1	1	
R12	RES, MF, 102K +/-1%, 1/8W	291286	91637	CMF551023F	1		
R13	RES, MF, 2K +/-1%, 1/8W	235226	91637	CMF552001F	1		
R14	RES, MF, 1M +/-1%, 1/8W	268797	91637	CMF551004F	2		
R15	RES, VAR, 100K +/-20%, 1/2W	268581	75378	190PC104B	2	1	
R16	RES, MF, 60.4K +/-1%, 1/8W	291419	91637	CMF556042F	2		
R17	RES, MF, 60.4K +/-1%, 1/8W	291419	91637	CMF556042F	REF		
R18	RES, MF, 3.92K +/-1%, 1/8W	294801	91637	CMF553921F	2		
R19	RES, VAR, 100 +/-20%, 1/2W	267823	75378	190PC101B	1	1	
R20	RES, MF, 3.92K +/-1%, 1/8W	294801	91637	CMF553921F	REF		
R21	RES, MF, 10K +/-1%, 1/8W	168260	91637	CMF551002F	3		
R22	RES, MF, 10K +/-1%, 1/8W	168260	91637	CMF551002F	REF		
R23	RES, DEP CAR, 100 +/-5%, 1/4W	348771	80031	CR251-4-5P100ET	2		
R24	RES, MF, 1M +/-1%, 1/8W	268797	91637	CMF551004F	REF		
R25	RES, MF, 1K +/-1%, 1/8W	168229	91637	CMF551001F	1		
R26	RES, VAR, 100K +/-20%, 1/2W	268581	75378	190PC104B	REF		
R27	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R28	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R29	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R30	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R31	RES, DEP CAR, 2.2K +/-5%, 1/4W	343400	80031	CR251-4-5P2K2T	REF		
R32	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R33	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R34	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R35	RES, DEP CAR, 5.1K +/-5%, 1/4W	368712	80031	CR251-4-5P5K1T	1		
R36	RES, DEP CAR, 47K +/-5%, 1/4W	348896	80031	CR251-4-5P47KT	1		
R37	RES, DEP CAR, 240 +/-5%, 1/4W	376624	80031	CR251-4-5P240E	1		
R38	RES, DEP CAR, 3.9K +/-5%, 1/4W	342600	80031	CR251-4-5P3K9T	1		
R39	RES, DEP CAR, 6.8K +/-5%, 1/4W	368761	80031	CR251-4-5P6K8T	2		
R40	RES, DEP CAR, 4.3K +/-5%, 1/4W	441576	80031	CR251-4-5P4K3T	1		
R41	RES, DEP CAR, 6.8K +/-5%, 1/4W	368761	80031	CR251-4-5P6K8T	REF		
R42	RES, DEP CAR, 3.3K +/-5%, 1/4W	348813	80031	CR251-4-5P3K3T	1		
R43	RES, DEP CAR, 330 +/-5%, 1/4W	368720	80031	CR251-4-5P330T	1		
R44	RES, MF, 1.02K +/-1%, 1/8W	223545	91637	CMF551021F	1		

Table 602-5. A4 Output Option PCB Assembly (cont)

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
R45	RES, MF, 10K +/-1%, 1/8W	168260	91637	CMF551002F	REF		
R46	RES, MF, 9.09K +/-1%, 1/8W	221663	91637	CMF559091F	1		
R47	RES, DEP CAR, 100 +/-5%, 1/4W	348771	80031	CR251-4-5P100ET	REF		
R48	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R49	RES, MF, 4.32K +/-1%, 1/8W	294819	91637	CMF554321F	1		
R50	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R51	RES, DEP CAR, 39K +/-5%, 1/4W	442400	80031	CR251-4-5P39KT	1		
R52	RES, MF, 100K +/-1%, 1/8W	248807	91637	CMF551003F	1		
R53	RES, MF, 64.9K +/-1%, 1/8W	288530	91637	CMF556492F	1		
R54	RES, MF, 226K +/-1%, 1/8W	320879	91637	CMF2263F	1		
R55	RES, MF, 309K +/-1%, 1/8W	235283	91637	CMF553093F	1		
S1	SWITCH	408559	00779	435166-2	3		
S2	SWITCH	408559	00779	435166-2	REF		
S3	SWITCH	408559	00779	435166-2	REF		
T1	XFMR, DC-DC CONV	461954	89536	461954	1		
U1	IC, CMOS, HEX BUFFER/INVERTER	381830	04713	MC14050CP	1	1	
U2	OPTO-ISOLATOR	380014	01295	T1L116	3	1	
U3	OPTO-ISOLATOR	380014	01295	T1L116	REF		
U4	OPTO-ISOLATOR	380014	01295	T1L116	REF		
U5	RES, NETWORK	413286	89536	413286	1	1	
U6	IC, CMOS, HEX, OPEN DRAIN BUFFERS	473389	12040	MM74C906N	1	1	
U7	IC, MOS, MICROPROCESSOR, N-CHANNEL	483396	50088	MK3870/14	1	1	
U8	IC, CMOS, TRI-STATE, HEX, NON-INV BUFF	407759	04713	MC14503CP	2	1	
U9	IC, CMOS, TRI-STATE, HEX, NON-INV BUFF	407759	04713	MC14503CP	REF		
U10	IC, CMOS, HEX INVERTERS	404681	04713	MC1406BCP	1	1	
U11	IC, CMOS, QUAD, BI-LATERAL SW	363838	02735	CD4016AE	2	1	
U12	IC, CMOS, QUAD, BI-LATERAL SW	363838	02735	CD4016AE	REF		
U13	IC, LINEAR, OP-AMP, J-FET INPUT	483438	89536	483438	1	1	
U14	XSTR, J-FET, N-CHANNEL	460014	89536	460014	1	1	
U15	RES, NETWORK	412726	89536	412726	2	1	
U16	IC, CMOS, QUAD, EXCLUSIVE OR	355222	02735	CD4030AE	1	1	
U17	IC, CMOS, DUAL 4-INPUT, NOR GATE	363820	04713	MC14025CP	1	1	
U18	IC, LINEAR, OP-AMP, J-FET INPUT	454454	89536	454454	1	1	
U19	IC, LINEAR, VOL REG, FXD	413187	04713	MC7815CP	1	1	
U20	IC, LINEAR, NEG, VOL REG	413179	04713	MC7915CT	1	1	
U21	RES, NETWORK	412726	89536	412726	REF		
U22	IC, LINEAR, LO-PWR DUAL VOL COMP	478354	12040	LM393N	1	1	
XU7	SOCKET, IC, 40-PIN	418988	91506	340-AG39D	1		
Y1	CRYSTAL	474072	89536	474072	1		

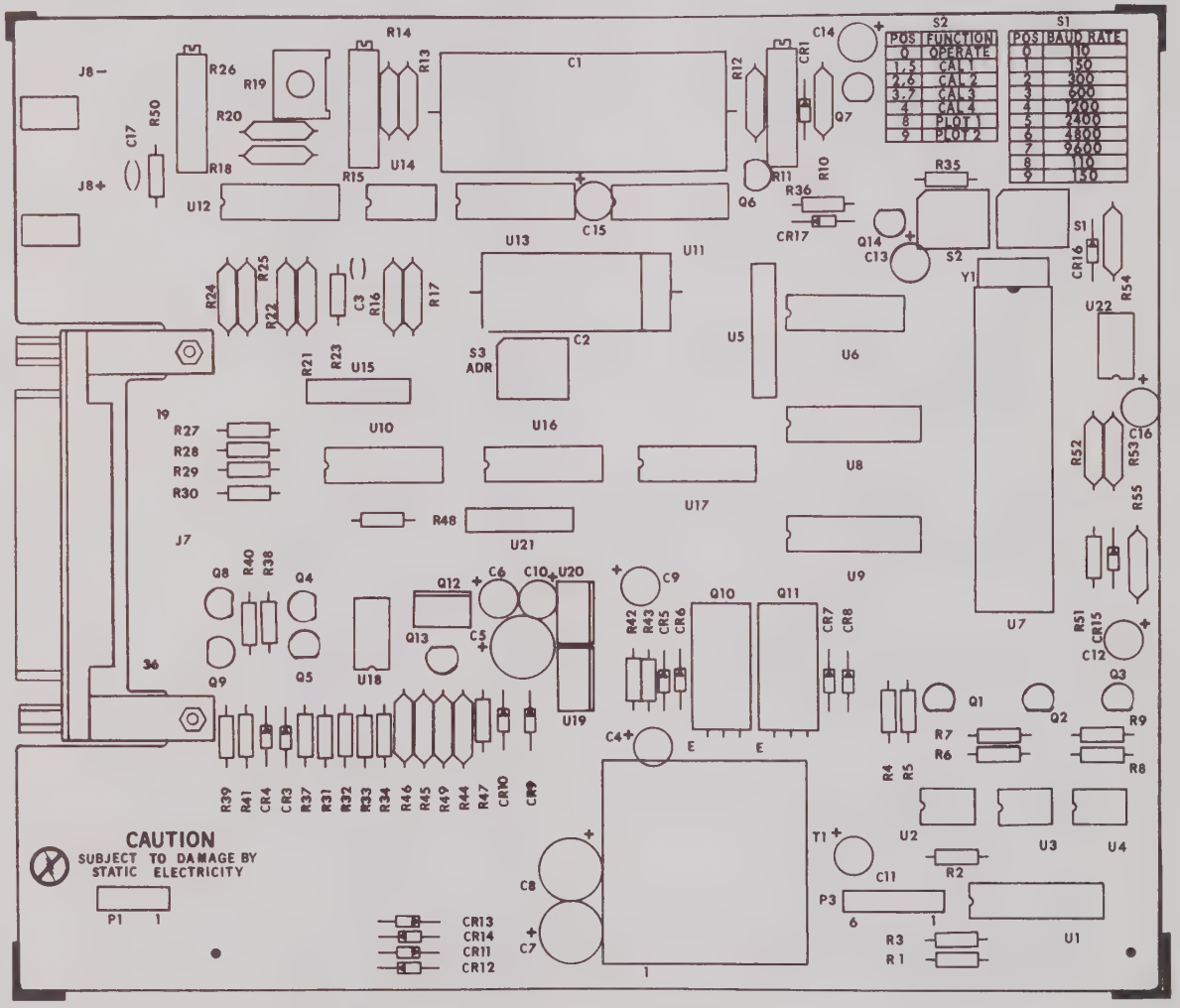


Figure 602-2. A4 Output Option PCB Assembly

Option -006
Limits

606-1. INTRODUCTION

606-2. The 21X0-006 Limits Option gives both the 2180A and 2190A digital thermometers the additional capability of providing LED and relay indications when the temperature exceeds certain preset conditions. Also selectable are, all for a single point, the delta function (displays the difference between the preset value and the temperature read), and the maximum/minimum display function (the highest or lowest temperature read since the last reset by the INITIALIZE MAX/MIN SWITCH).

606-3. The Limits Option is available as factory installed with initial order or may be ordered as a field installable kit for addition to the instrument.

606-4. SPECIFICATIONS

606-5. Specifications for the Limits Option, 21X0-006, are listed in Table 606-1.

Table 606-1. Specifications

Limits Function: lights LED and activates Form A (SPST) relay when a preset limit is exceeded. Contacts rated at 10 VA, 184V dc or 130V ac rms max, 0.5A max, resistive.
Min/Max Function: Store min or max readings, resettable from front panel.
△ **Temperature Function:** Reads ± temperature deviations from preset nominal temperature.
Installable: Factory or field, through pre-punched front panel.

Function:	Limit:
≤ Low Limit	−9999°
> High Limit	+9999°
Store min reading	Not used
Store max reading	Not used
△ ± Deviation from	Nominal

606-6. INSTALLATION

606-7. Options for field installation can be installed using the following procedure:

WARNING

HAZARDOUS VOLTAGES MAY BE PRESENT WITHIN THE INSTRUMENT. ONLY QUALIFIED PERSONNEL SHOULD PERFORM THIS INSTALLATION PROCEDURE.

1. Disconnect the thermometer from all power sources.
2. Remove the screws on the bottom of the case that fasten the top and bottom of the PTI together and remove the top half of the case.
3. Remove the hole plugs from the Limit section of the front panel and attach the standoffs supplied with the option to the front panel.
4. Position the Limits PCB so that the thumbwheel LED and pushbutton switch line up with the applicable front panel ports.
5. Attach the Limits PCB to the Main PCB using the screws supplied with the option.
6. Connect the cable on the Limits PCB to J4 on the Main PCB.
7. Replace the PTI cover on the instrument and reconnect to power sources, if required at this time.

606-8. OPERATING NOTES

606-9. Installation of the Limits Option enables the low current single contact relay (K1) on the thermometer Main PCB. The contact points are available on a rear panel connector block.

NOTE

Once installed there are no provisions for disabling the limits option. If a temperature display is desired without the relay or LED indications select one of the Limits functions (> or ≤) and the maximum setting on the numeric thumbwheel switches.

6-10. OPERATION

6-11. The position and general description of the Limit Option front panel controls are given in Section 2. A more detailed description of the three functions is given in the following paragraphs.

606-12. Limit Function

606-13. The limit function is enabled when the function portion of the thumbwheel is set in either ≤ or > position. The front panel LED illuminates and the rear panel relay contacts close when either of the preset conditions are met. In the greater than (>) function the indications (LED and relay contacts) result from any temperature reading that exceeds the value set on the limit thumbwheel. The less than (≤) function gives its indication when the temperature read by the thermometer is equal to, or less than, the value set on the limit thumbwheels. The thumbwheel LSD is a whole number, fractional entries cannot be made.

606-14. Delta Function

606-15. When the delta (Δ) function is selected on the thumbwheel the thermometer display reads the difference between the temperature at the thermocouple and the whole number setting of the thumbwheels. The formula used for the computation is :

T displayed = T at thermocouple - T thumbwheel setting (in degrees)

606-16. MINIMUM/MAXIMUM Display Function

606-17. The microprocessor accumulates and stores the highest and lowest temperatures recorded since the last reset. When the maximum (↑) function is selected the highest temperature recorded, and stored, in the microprocessor is displayed. Selection of the minimum function (↓) displays the lowest recorded temperature since the last reset. To record the current temperature for either function, select the applicable function and depress the front panel reset switch.

606-18. THEORY OF OPERATION

606-19. The -006 option supplies the thermometer with the function and numeric data selected on the front panel mechanical thumbwheel switches. When a Limit function is selected the data is stored for comparison on the option pcb. All communication between the option and the thermometer is done on the clocked serial accessory bus. This bus transmits and receives addresses, thumbwheel data, reset data, and limit status. Refer to the schematic in Section 8 during the Theory of Operation discussion.

606-20. Addressing

606-21. Each of the options on the bus is addressed with a different code. The thermometer uses the address "6" to talk to the Limits Option. To talk to any option the $\overline{\text{WRTADR}}$ (P4-3) line must be brought low with $\overline{\text{WRT}}$ (P4-4) high followed by the applicable four address bit applied to the $\overline{\text{DATA}}$ (P4-5) line in succession, toggling $\overline{\text{DCLK}}$ (P4-6) for each bit. This clocks the address into the shift register (U2-15) where it is compared to the Limit Option address and, if valid, (U1-1 low) enables the gates required to shift data to the thermometer (U5-11) and into the limits option (U5-2). Details of the data transfer are in subsequent paragraphs.

606-22. Limits Option Outputs

606-23. Before the thermometer can input data from the Limits Option the Limits circuitry must be addressed as described previously (U1-1 low). Once addressed the $\overline{\text{WRTADR}}$ and $\overline{\text{WRT}}$ lines go high. The low to high transition of $\overline{\text{WRTADR}}$ (U3-6) loads the shift registers from the thumbwheel and RESET switches. The two lines enable the output data line (U1-13) and as the thermometer accepts the data it clocks the serial output shift registers with $\overline{\text{DCLK}}$, transferring the data from the shift register to the thermometer.

606-24. In the thermometer the data is processed by the microprocessor to perform the proper action. For the limits function the output is compared to the state of the limits and, if exceeded, the indicator illuminated and the relay energized. For the delta function the temperature is compared against the transmitted value and the difference displayed. If either the maximum or minimum function is selected the stored value is displayed, but, in addition, the status of the RESET switch is checked.

606-25. Limits Option Inputs

606-26. The thermometer transmits to the Limits Option only the Limits Exceeded status. After the option has been addressed (U1-1) $\overline{\text{WRTADR}}$ goes high to disable the addressing circuit (U4-13) while $\overline{\text{WRT}}$ stays low to enable the Limits Exceeded input (U5-8) so that $\overline{\text{DCLK}}$ can clock the data into the latch (U5-1). A Limit Exceeded indication clocks a high into the latch resulting in a low at the output (U6-12) to turn on CR1. The limit not exceeded, or another function selected, loads a low into the latch to turn off the indicator.

606-27. CALIBRATION

606-28. The Limits Option has no variabe components and does not require calibration.

606-29. TROUBLESHOOTING

606-30. Troubleshooting for the 21X0A Option-006, Limits, consists of the tabular flow chart in Table 606-2. When a step on the flow chart is completed, check for a decision transfer. If no decision is required, perform the next step of the table in sequence.

606-31. LIST OF REPLACEABLE PARTS

606-32. Table 606-3 is a list of replaceable parts for the Limits Option. Refer to Section 5 for an explanation of the columnar entries.

Table 606-2. Limits Option Troubleshooting

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
	NOTE *These tests are based on the assumption that the 2180A/2190A has been thoroughly checked out and is free of troubles prior to beginning the test of the Limits Option –006.*		
1	Select the less than or equal function (≤) and set the thumbwheels for anumeric such that the thermocouple input exceeds the preset numeric (e.g., thumbwheels set at +1111 and the ambient temperature used as the thermocouple input).		
2	Does the LIMIT indicator illuminate and the rear panel relay contacts close?	26	3
3	Is the +4 Vdc input from the Main PCB present?	5	4
4	Check the +5 Vdc input, repair as required then resume at Step 1.		
5	Does the signal at U1-1 toggle (vary between logic high and logic low) when viewed with a scope?	13	6
6	Do the $\overline{\text{WRT}}$, $\overline{\text{WRTADR}}$ and $\overline{\text{DCLK}}$ lines toggle?	8	7
7	Check the inputs on the cable from the microprocessor on the Main PCB. Repair as required then resume at Step 1.		
8	Does the $\overline{\text{DATA}}$ line toggle?	10	9
9	Check the cabling and Q1, Q2, U3-8 and their associated components. Repair as required then resume at Step 1.		
10	Are the clock and data signals present at pins 1 and 15 of U2, respectively?	12	11
11	Check U1, U2-2, 11, 12, 13 and U3. Repair as required then resume at Step 1.		
12	Check U4 for the clock and U6 for loading of the data line. Repair as required then resume at Step 1.		
13	Is the function code (≤) a BCD 0 with pins 4, 5, and 6 of U7 low, the sign (+) at U7-7 high, the numeric MSD BCD code as set at pins 1, 15, 14 and 13 of U9, the second MSD BCD code as set at pins 4, 5, 6, and 7 of U11?	15	14
14	Check the switches and their associated components. Reapir as required then resume at Step 1.		
15	Is the clock present at U7-10, U9-10, and U11-10?	17	16
16	Check U4-10, U1-13 and their inputs. Repair as required then resume at Step 1.		
17	Does the signal at U11-3, U9-3, and U7-3 toggle?	19	18
18	Check U11, U9, and U7. Repair as required then resume at Step 1.		
19	Does the $\overline{\text{DATA}}$ line toggle?	21	20
20	Check Q1, Q2, U3, U5-10 and their associated components. Repair as required then resume at Step 1.		
21	Are the clock and data signals present at pins 11 and 9 of U6, respectively?	23	22

Table 606-2. Limits Option Troubleshooting (cont)

STEP NO.	ACTION	Go to the step number given for correct response	
		YES	NO
22	Check U5 for the clock, repair as required then resume at Step 1.		
23	Is the collector of Q9 low?	25	24
24	Check Q9, Q3, U6-12 and their associated components. Repair as required then resume at Step 1.		
25	Check the indicator CR1 and the relay on the Main PCB. Repair as required then resume at Step 1.		
26	Set the FUNCTION switch to greater than (>) and input a temperature from the thermocouple that exceeds the preset limit.		
27	Does the LIMIT indicator illuminate and the relay contacts close?	29	28
28	Check for a Function BCD code of 1 (001) at pins 4, 5, and 6 of U7. The sign at U7-7 is high for plus and low for minus. Check that the thumbwheel switches reflect the BCD codes set on them. Repair as required then resume at Step 1.		
29	Set the FUNCTION switch to the Delta (Δ) position and set the thumbwheels to the desired base.		
30	Is the difference between the thermocouple input and the preset base displayed?	32	31
31	Check for a Function of BCD code of 2 (010) at pins 4, 5, and 6 of U7. Check that the thumbwheel switches reflect the BCD codes set on them. Repair as required then resume at Step 29.		
32	Set the FUNCTION switch to the minimum (⤓) position and depress the INITIALIZE MIN/MAX switch.	i n	
33	Does the thermometer display reflect the lowest temperature input from the thermocouple since the switch was depressed?	35	34
34	Check for a Function BCD code of 3 (011) at pins 4, 5, and 6 of U7. Check U2-4 and 5, U4-3 and 4, U6-1, the initialize switch S7 and their associated components. Repair as required then resume at Step 32.		
35	Set the FUNCTION switch to the MAXIMUM (⤒) position and depress the INITIALIZE MIN/MAX switch.		
36	Does the thermometer display reflect the highest temperature input from the thermocouple since the switch was depressed?	38	37
37	Check for a Function BCD code of 4 (100) at pins 4, 5, and 6 of U7. Repair as required then resume at Step 35.		
38	Troubleshooting of the 21X0-006 Limits Option is complete.		

Table 606-3. A5 Limits Option PCB Assembly

ITEM NO.	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO. OR TYPE	TOT QTY	REC QTY	USE CDE
A5	LIMITS OPTION PCB ASSY (2180A-4160)	-006	89536	2190A-006	REF		
S1-S6	THUMBWHEEL SWITCH ASSY	472803	89536	472803	1		
CR1	LED, RED	385914	09214	SSL-22	1	1	
MP1	LED, STANDOFF ASSY	472548	89536	472548	1		
P4	CABLE	474379	00779	86946-6	1		
Q1	XSTR, SI, PNP	195974	04713	2N3906	1	1	
Q2	XSTR, SI, NPN	218396	04713	2N3904	3	1	
Q3	XSTR, SI, NPN	218396	04713	2N3904	REF		
Q9	XSTR, SI, NPN	218396	04713	2N3904	REF		
R1	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	6		
R2	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R3	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R4	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R5	RES, DEP CAR, 100K +/-5%, 1/4W	348920	80031	CR251-4-5P100KT	1		
R6	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R7	RES, DEP CAR, 240 +/-5%, 1/4W	376624	80031	CR251-4-5P240ET	1		
R8	RES, DEP CAR, 10K +/-5%, 1/4W	348839	80031	CR251-4-5P10KT	REF		
R9	RES, DEP CAR, 20K +/-5%, 1/4W	441477	80031	CR251-4-5P20KT	1		
R10	RES, DEP CAR, 2.2K +/-5%, 1/4W	343400	80031	CR251-4-5P2K2T	1		
S7-1	PUSHBUTTON	472332	89536	4723322	1		
S7-2	SWITCH COVER	401299	89536	401299	1		
S7-3	SWITCH ACTUATOR	412106	89536	412106	1		
S7-4	SWITCH SPRING	414516	00779	62312	1		
S7-5	SWITCH CONTACT	416875	00779	62313	1		
U1	IC, CMOS, DUAL 4-IN POS NAND GATE	355206	04713	MC14012CP	1	1	
U2	IC, CMOS, DUAL 4-BIT STATIC SHIFT REGTR	340125	04713	MC14015BCP	1	1	
U3	IC, CMOS, HEX INVERTER	404681	04713	MC1406BCP	1	1	
U4	IC, CMOS, 3-IN INV NOR GATE	355172	04713	MC14001CP	1	1	
U5	IC, CMOS, 3-IN NOR GATE	355180	04713	MC14025CP	1	1	
U6	IC, CMOS, DUAL, D-TYPE FLIP-FLOP	340117	04713	MC14013CP	1	1	
U7	IC, CMOS, 8-STAGE STATIC SHIFT REGSTR	380766	12040	MM5621AN	3	1	
U8	RES, NETWORK, 100K	412908	89536	412908	3	1	
U9	IC, CMOS, 8-STAGE STATIC SHIFT REGSTR	380766	12040	MM5621AN	REF		
U10	RES, NETWORK, 100K	412908	89536	412908	REF		
U11	IC, CMOS, 8-STAGE STATIC SHIFT REGSTR	380766	12040	MM5621AN	REF		
U12	RES, NETWORK, 100K	412908	89536	412908	REF		

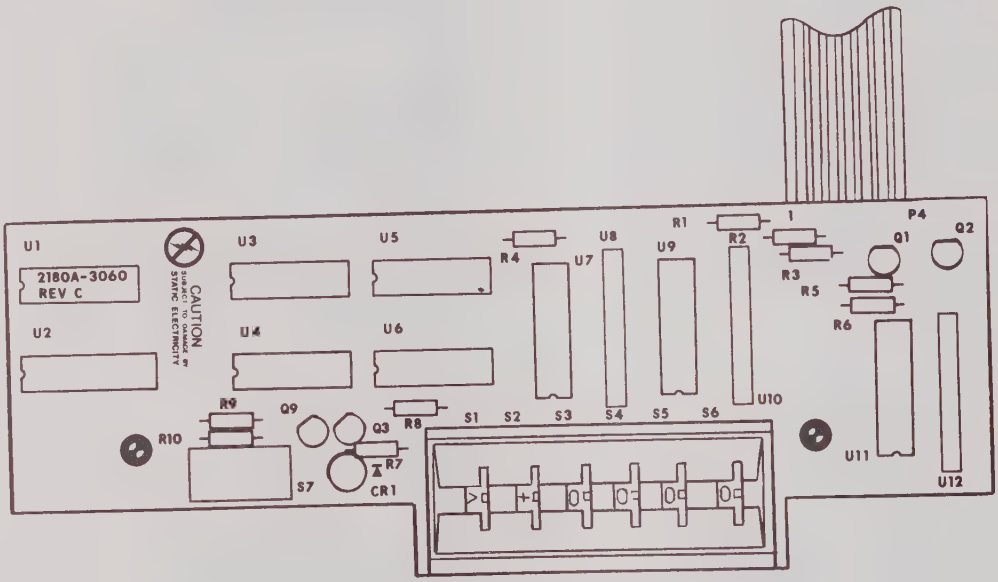


Figure 606-1. A5 Limits Option PCB Assembly

Section 7

General Information

7-1. This section of the manual contains generalized user information as well as supplemental information to the List of Replaceable parts contained in Section 5. The following information is presented in this section:

List of Abbreviations

Federal Supply Codes for Manufacturers

Fluke Technical Service Centers — U.S. and Canada

Sales and Service Locations — International

Sales Representatives — U.S. and Canada

A or amp	ampere
ac	alternating current
af	audio frequency
a/d	analog-to-digital
assy	assembly
AWG	american wire gauge
B	bel
bcd	binary coded decimal
^{o}C	Celsius
cap	capacitor
ccw	counterclockwise
cer	ceramic
cermet	ceramic to metal(seal)
ckt	circuit
cm	centimeter
cmrr	common mode rejection ratio
comp	composition
cont	continue
crt	cathode-ray tube
cw	clockwise
d/a	digital-to-analog
dac	digital-to-analog converter
dB	decibel
dc	direct current
dmm	digital multimeter
dvm	digital voltmeter
elect	electrolytic
ext	external
F	farad
^{o}F	Fahrenheit
FET	Field-effect transistor
ff	flip-flop
freq	frequency
FSN	federal stock number
g	gram
G	giga (10^{9})
gd	guard
Ge	germanium
GHz	gigahertz
gmv	guaranteed minimum value
gnd	ground
H	henry
hd	heavy duty
hf	high frequency
Hz	hertz
IC	integrated circuit
if	intermediate frequency
in	inch(es)
intl	internal
I/O	input/output
k	kilo (10^{3})
kHz	kilohertz
kΩ	kilohm(s)
kV	kilovolt(s)
lf	low frequency
LED	light-emitting diode
LSB	least significant bit
LSD	least significant digit
M	mega (10^{6})
m	milli (10^{-3})
mA	milliampere(s)
max	maximum
mf	metal film
MHz	megahertz
min	minimum
mm	millimeter
ms	millisecond
MSB	most significant bit
MSD	most significant digit
MTBF	mean time between failures
MTTR	mean time to repair
mV	millivolt(s)
mv	multivibrator
MΩ	megohm(s)
n	nano (10^{-9})
na	not applicable
NC	normally closed
(–) or neg	negative
NO	normally open
ns	nanosecond
opnl ampl	operational amplifier
p	pico (10^{-12})
para	paragraph
pcb	printed circuit board
pF	picofarad
pn	part number
(+) or pos	positive
pot	potentiometer
p-p	peak-to-peak
ppm	parts per million
PROM	programmable read-only memory
psi	pound-force per square inch
RAM	random-access memory
rf	radio frequency
rms	root mean square
ROM	read-only memory
s or sec	second (time)
scope	oscilloscope
SH	shield
Si	silicon
serno	serial number
sr	shift register
Ta	tantalum
tb	terminal board
tc	temperature coefficient or temperature compensating
tcxo	temperature compensated crystal oscillator
tp	test point
u or μ	micro (10^{-6})
uhf	ultra high frequency
us or μs	microsecond(s) (10^{-6})
uut	unit under test
V	volt
v	voltage
var	variable
vco	voltage controlled oscillator
vhf	very high frequency
vlf	very low frequency
W	watt(s)
ww	wire wound
xfmr	transformer
xstr	transistor
xtal	crystal
xtlo	crystal oscillator
Ω	ohm(s)
μ	micro (10^{-6})

00213
Nytronics Comp. Group Inc.
Subsidiary of Nytronics Inc.
Formerly Sage Electronics
Rochester, New York

00327
Welwyn International, Inc.
Westlake, Ohio

00656
Aerovox Corp.
New Bedford, Massachusetts

00686
Film Capacitors, Inc.
Passaic, New Jersey

00779
AMP Inc.
Harrisberg, Pennsylvania

01121
Allen-Bradley Co.
Milwaukee, Wisconsin

01281
TRW Electronic Comp.
Semiconductor Operations
Lawndale, California

01295
Texas Instruments, Inc.
Semiconductor Group
Dallas, Texas

01537
Motorola Communications &
Electronics Inc.
Franklin Park, Illinois

01686
RCL Electronics Inc.
Manchester, New Hampshire

01730
Replaced by 73586

01884 - use 56289
Sprague Electric Co.
Dearborn Electronic Div.
Lockwood, Florida

02114
Ferroxcube Corp.
Saugerties, New York

02131
General Instrument Corp.
Harris ASW Div.
Westwood, Maine

02395
Rason Mfg. Co.
Brooklyn, New York

02533
Snelgrove, C.R. Co., Ltd.
Don Mills, Ontario, Canada
M3B 1M2

02606
Fenwal Labs
Div. of Travenal Labs.
Morton Grove, Illinois

02660
Bunker Ramo Corp., Conn Div.
Formerly Amphenol-Borg
Electric Corp.
Broadview, Illinois

02799
Areo Capacitors, Inc.
Chatsworth, California

03508
General Electric Co.
Semiconductor Products
Syracuse, New York

03614
Replaced by 71400

03651
Replaced by 44655

03797
Eldema Div.
Genisco Technology Corp.
Compton, California

03877
Transistron Electronic Corp.
Wakefield, Massachusetts

03888
KDI Pyrofilm Corp.
Whippany, New Jersey

03911
Clairex Electronics Div.
Clairex Corp.
Mt. Vernon, New York

03980
Muirhead Inc.
Mountainside, New Jersey

04009
Arrow Hart Inc.
Hartford, Connecticut

04062
Replaced by 72136

04202
Replaced by 81312

04217
Essex International Inc.
Wire & Cable Div.
Anaheim, California

04221
Aemco, Div. of
Midtex Inc.
Mankato, Minnesota

04222
AVX Ceramics Div.
AVX Corp.
Myrtle Beach, Florida

04423
Telonic Industries
Laguna Beach, California

04645
Replaced by 75376

04713
Motorola Inc. Semiconductor
Products
Phoenix, Arizona

04946
Standard Wire & Cable
Los Angeles, California

05082
Replaced by 94988

05236
Jonathan Mfg. Co.
Fullerton, California

05245
Components Corp. now
Corcom, Inc.
Chicago, Illinois

05277
Westinghouse Electric Corp.
Semiconductor Div.
Youngwood, Pennsylvania

05278
Replaced by 43543

05279
Southwest Machine &
Plastic Co.
Glendora, California

05397
Union Carbide Corp.
Materials Systems Div.
New York, New York

05571 - use 56289
Sprague Electric Co.
Pacific Div.
Los Angeles, California

05574
Viking Industries
Chatsworth, California

05704
Replaced by 16258

05820
Wakefield Engineering Inc.
Wakefield, Massachusetts

06001
General Electric Co.
Electronic Capacitor &
Battery Products Dept.
Columbia, South Carolina

06136
Replaced by 63743

06383
Panduit Corp.
Tinley Park, Illinois

06473
Bunker Ramo Corp.
Amphenol SAMS Div.
Chatsworth, California

06555
Beede Electrical Instrument Co.
Penacook, New Hampshire

06739
Electron Corp.
Littleton, Colorado

06743
Clevite Corp.
Cleveland, Ohio

06751
Components, Inc. Semcor Div.
Phoenix, Arizona

06860
Gould Automotive Div.
City of Industry, California

06961
Vernitron Corp., Piezo
Electric Div.
Formerly Clevite Corp., Piezo
Electric Div.
Bedford, Ohio

06980
Eimac Div.
Varian Associates
San Carlos, California

07047
Ross Milton, Co., The
South Hampton, Pennsylvania

07115
Replaced by 14674

07138
Westinghouse Electric Corp.,
Electronic Tube Division
Horsehead, New York

07233
TRW Electronic Components
Cinch Graphic
City of Industry, California

07256
Silicon Transistor Corp.
Div. of BBF Group Inc.
Chelmsford, MA

07261
Aumet Corp.
Culver City, California

07263
Fairchild Semiconductor
Div. of Fairchild Camera
& Instrument Corp.
Mountain View, California

07344
Bircher Co., Inc.
Rochester, New York

07597
Burndy Corp.
Tape/Cable Div.
Rochester, New York

07792
Lerma Engineering Corp.
Northampton, Massachusetts

07910
Teledyne Semiconductor
Formerly Continental Device
Hawthorne, California

07933 - use 49956
Raytheon Co.
Semiconductor Div. HQ
Mountain View, California

08225
Industro Transistor Corp.
Long Island City, New York

08261
Spectra Strip Corp.
Garden Grove, California

08530
Reliance Mica Corp.
Brooklyn, New York

08806
General Electric Co.
Miniature Lamp Products Dept.
Cleveland, Ohio

08863
Nylomatic Corp.
Norrisville, Pennsylvania

08988 - use 53085
Skottie Electronics Inc.
Archbald, Pennsylvania

09214
G.E. Co. Semi-Conductor
Products Dept.
Power Semi-Conductor
Products OPN Sec.
Auburn, New York

09353
C and K Components
Watertown, Massachusetts

09423
Scientific Components, Inc.
Santa Barbara, California

09922
Burndy Corp.
Norwalk, Connecticut

09969
Dale Electronics Inc.
Yankton, S. Dakota

10059
Barker Engineering Corp.
Formerly Amerace, Amerace
ESNA Corp.
Kenilworth, New Jersey

11236
CTS of Berne
Berne, Indiana

11237
CTS Keene Inc.
Paso Robles, California

11358
CBS Electronic Div.
Columbia Broadcasting System
Newburyport, MN

11403
Best Products Co.
Chicago, Illinois

11503
Keystone Columbia Inc.
Warren, Michigan

11532
Teledyne Relays
Hawthorne, California

11711
General Instrument Corp
Rectifier Division
Hickville, New York

11726
Qualidyne Corp.
Santa Clara, California

12014
Chicago Rivet & Machine Co.
Bellwood, Illinois

12040
National Semiconductor Corp.
Danburry, Connecticut

12060
Diodes, Inc.
Chatsworth, California

12136
Philadelphia Handle Co.
Camden, New Jersey

12300
Potter-Brumfield Division
AMF Canada LTD.
Guelph, Onatrio, Canada

12323
Presin Co., Inc.
Shelton, Connecticut

12327
Freeway Corp. formerly
Freeway Washer & Stamping Co.
Cleveland, Ohio

12443
Budd Co. The, Polychem Products
Plastic Products Div.
Bridgeport, PA

12615
U.S. Terminals Inc.
Cincinnati, Ohio

12617
Hamlin Inc.
Lake Mills, Wisconsin

12697
Clarostat Mfg. Co.
Dover, New Hampshire

12749
James Electronics
Chicago, Illinois

12856
Micrometals
Sierra Madre, California

12954
Dickson Electronics Corp.
Scottsdale, Arizona

12969
Unitrode Corp.
Watertown, Massachusetts

13103
Thermalloy Co., Inc.
Dallas, Texas

13327
Solitron Devices Inc.
Tappan, New York

13511
Amphenol Cadre Div.
Bunker-Ramo Corp.
Los Gatos, California

13606 - use 56289
Sprague Electric Co.
Transistor Div.
Concord, New Hampshire

13839
Replaced by 23732

14099
Semtech Corp.
Newbury Park, California

14140
Edison Electronic Div.
Mc Gray-Edison Co.
Manchester, New Hampshire

14193
Cal-R-Inc. formerly
California Resistor, Corp.
Santa Monica, California

14298
American Components, Inc.
an Insilco Co.
Conshohocken, Pennsylvania

14655
Cornell-Dublier Electronics
Division of Federal Pacific
Electric Co. Govt. Control Dept.
Newark, New Jersey

14752
Electro Cube Inc.
San Gabriel, California

14869
Replaced by 96853

14936
General Instrument Corp.
Semi Conductor Products Group
Hicksville, New York

15636
Elec-Trol Inc.
Saugus, California

15801
Fenwal Electronics Inc.
Div. of Kidde Walter and Co., Inc.
Framingham, Massachusetts

15818
Teledyne Semiconductors, formerly
Amelco Semiconductor
Mountain View, California

15849
Litton Systems Inc. Useco Div.
formerly Useco Inc.
Van Nuys, California

15898
International Business
Machines Corp.
Essex Junction, Vermont

15909
Replaced by 14140

16258
Space-Lok Inc.
Burbank, California

16299
Corning Glass
Electronic Components Div.
Raleigh, North Carolina

16332
Replaced by 28478

16473
Cambridge Scientific Ind.
Div. of Chemed Corporation
Cambridge, Maryland

16742
Paramount Plastics Fabricators, Inc.
Downey, California

16758
Delco Electronics
Div. of General Motors Corp.
Kokomo, Indiana

17001
Replaced by 71468

17069
Circuit Structures Lab.
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17338
High Pressure Eng. Co., Inc.
Oklahoma City, Oklahoma

17545
Atlantic Semiconductors, Inc.
Asbury Park, New Jersey

17856
Siliconix, Inc.
Santa Clara, California

17870
Replaced by 14140

18178
Vactec Inc.
Maryland Heights, Missouri

18324
Signetics Corp.
Sunnyvale, California

18612
Vishay Resistor Products Div.
Vishay Intertechnology Inc.
Malvern, Pennsylvania

18736
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Hanover, New Jersey

18927
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Titusville, Pennsylvania

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19701
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Indianapolis, Indiana

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Self-Organizing Systems, Inc.
Dallas, Texas

21604
Buckeye Stamping Co.
Columbus, Ohio

21845
Solitron Devices Inc.
Transistor Division
Riveria Beach, Florida

22767
ITT Semiconductors
Palo Alto, California

23050
Product Comp. Corp.
Mount Vernon, New York

23732
Tracor Inc.
Rockville, Maryland

23880
Stanford Applied Engrng.
Santa Clara, California

23936
Pamotor Div., Wm. J. Purdy Co.
Burlingame, California

24248
Replaced by 94222

24355
Analog Devices Inc.
Norwood, Massachusetts

24655
General Radio
Concord, Massachusetts

24759
Lenox-Fugle Electronics Inc.
South Plainfield, New Jersey

25088
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27264
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Deltrol Corporation
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Replaced by 06980

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Replaced by 90303

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Hicksville, LI, New York

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West Hartford, Connecticut

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Trenton, New Jersey

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Chicago, Illinois

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Radio Switch Corp.
Marlboro, New Jersey

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Signalite Div.
General Instrument Corp.
Neptune, New Jersey

74306
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Carlisle, Pennsylvania

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Penacook, New Hampshire

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Div. of Illinois Tool Works Inc.
Elgin, Illinois

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Saint Marys, Pennsylvania

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Cleveland, Ohio

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79497
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Goshen, Indiana

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A North American Phillips Co.
Morristown, New Jersey

80145
LFE Corp., Process Control Div.
formerly API Instrument Co.
Chesterland, Ohio

80183 - use 56289
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North Adams, Massachusetts

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Riverside, California

80583
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80640
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South Boston, Massachusetts

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La Grange, Illinois

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South Gate, California

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82872
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New York, New York

82877
Rotron Inc.
Woodstock, New York

82879
ITT Royal Electric Div.
Pawtucket, Rhode Island

83003
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Garland, Texas

83058
Carr Co., The United Can Div.
of TRW
Cambridge, Massachusetts

83298
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Electric Power Division
Eatontown, New Jersey

83330
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Brooklyn, New York

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West Haven, Connecticut

83594
Burroughs Corp.
Electronic Components Div.
Plainfield, New Jersey

83740
Union Carbide Corp.
Battery Products Div.
formerly Consumer Products Div.
New York, New York

84171
Arco Electronics
Great Neck, New York

84411
TRW Electronic Components
TRW Capacitors
Ogallala, Nebraska

84613
Fuse Indicator Corp.
Rockville, Maryland

84682
Essex International Inc.
Industrial Wire Div.
Peabody, Massachusetts

86577
Precision Metal Products,
of Malden Inc.
Stoneham, Massachusetts

86684
Radio Corp. of America
Electronic Components Div.
Harrison, New Jersey

86928
Seastrom Mfg. Co., Inc.
Glendale, California

87034
Illuminated Products Inc.
Subsidiary of Oak Industries Inc.
Anahiem, California

88219
Gould Inc.
Industrial Div.
Trenton, New Jersey

88245
Litton Systems Inc.
Useco Div.
Van Nuys, California

88419
Cornell-Dubilier Electronic Div.
Federal Pacific Co.
Fuquay-Varian, North Carolina

88486
Plastic Wire & Cable
Jewitt City, Connecticut

88690
Replaced by 04217

89536
Fluke, John Mfg. Co., Inc.
Seattle, Washington

89730
G.E. Co., Newark Lamp Works
Newark, New Jersey

90201
Mallory Capacitor Co. Div of
P.R. Mallory Co., Inc.
Indianapolis, Indiana

90211 - use 56365
Square D Co.
Chicago, Illinois

90215
Best Stamp & Mfg. Co.
Kansas City, Missouri

90303
Mallory Battery Co.
Div. of Mallory Co., Inc.
Tarrytown, New York

91094
Essex International Inc.
Suglex/IWP Div.
Newmarket, New Hampshire

91293
Johanson Mfg. Co.
Boonton, New Jersey

91407
Replaced by 58474

91502
Associated Machine
Santa Clara, California

91506
Augat Inc.
Attleboro, Massachusetts

91637
Dale Electronics Inc.
Columbus, Nebraska

91662
Elco Corp.
Willow Grove, Pennsylvania

91737 - use 71468
Gremar Mfg. Co., Inc.
ITT Cannon/Gremar
Santa Ana, California

91802
Industrial Devices, Inc.
Edgewater, New Jersey

91833
Keystone Electronics Corp.
New York, New York

91836
King's Electronics Co., Inc.
Tuckahoe, New York

91929
Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

91934
Miller Electric Co., Inc.
Div of Aunet
Woonsocket, Rhode Island

92194
Alpha Wire Corp.
Elizabeth, New Jersey

93332
Sylvania Electric Products
Semiconductor Products Div.
Woburn, Massachusetts

94145
Replaced by 49956

94154 - use 94988
Wagner Electric Corp.
Tung-Sol Div.
Newark, New Jersey

94222
Southco Inc. formerly
South Chester Corp.
Lester, Pennsylvania

95146
Alco Electronic Products Inc.
Lawrence, Massachusetts

95263
Leecraft Mfg. Co.
Long Island City, New York

95264
Replaced by 98278

95275
Vitramon Inc.
Bridgeport, Connecticut

95303
RCA Corp.
Receiving Tube Div.
Cincinnati, Ohio

95348
Gordo's Corp.
Bloomfield, New Jersey

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Rolling Meadows, Illinois

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96881
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97540
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97913
Industrial Electronic Hdware Corp.
New York, New York

97945
Penwalt Corp.
SS White Industrial Products Div.
Piscataway, New Jersey

97966
Replaced by 11358

98094
Replaced by 49956

98159
Rubber-Teck, Inc.
Gardena, California

98278
Malco A Microdot Co., Inc.
Connector & Cable Div.
Pasadena, California

98291
Sealectro Corp.
Mamaroneck, New York

98388
Royal Industries
Products Div.
San Diego, California

98743
Replaced by 12749

98925
Replaced by 14433

99120
Plastic Capacitors, Inc.
Chicago, Illinois

99217
Bell Industries Elect. Comp. Div.
formerly Southern Elect. Div.
Burbank, California

99392
STM
Oakland, California

99515
ITT Jennings Monrovia Plant
Div. of ITT Jennings formerly
Marshall Industries Capacitor Div.
Monrovia, California

99779 - use 29587
Bunker-Ramo Corp.
Barnes Div.
Landsdowne, Pennsylvania

99800
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East Aurora, New York

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COLORADO
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NORTH CAROLINA
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Minneapolis
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Zip: 02173
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7001 220th Ave. S.W.
Zip: 98043
Tel. (206) 774-2206

Canada

ALBERTA
Calgary
Fluke Canadian Technical Center
Ed Zahodnik, Service Manager
3829 12th St. N.E.
Zip: T2E 6M5
Tel. (403) 276-9658

ONTARIO
Mississauga
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6503 Northam Drive
Zip: L4V 1J5
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BELGIUM
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CYPRUS
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DENMARK
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FRANCE
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GERMAN FEDERAL REPUBLIC
Fluke (Deutschland) GmbH
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Tel: 211-450831

Fluke (Deutschland) GmbH
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West Germany
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GREECE
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ISRAEL
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NETHERLANDS
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SWEDEN
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P.O. Box 490
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TURKEY
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Elmeasco Instruments Pty. Ltd.
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JAPAN
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Trading & Agricultural
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Amman, Jordan
Tel: 23052

KENYA
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KOREA
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MALAYSIA
O'Connor's (Pte) Ltd.
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Appendix 7A
Manual Change Information

INTRODUCTION

This appendix contains information necessary to backdate the manual to conform with earlier pcb configurations. To identify the configuration of the pcb's used in your instrument, refer to the revision letter (marked in ink) on the component side of each pcb assembly. Table 7A-1 defines the assembly revision levels documented in this manual with an Z.

NEWER INSTRUMENTS

As changes and improvements are made to the instrument they are identified by incrementing the revision letter marked on the affected pcb assembly. These changes are documented on a supplemental change/errata sheet which, when applicable, is inserted at the front of the manual.

OLDER INSTRUMENTS

To backdate this manual to conform with earlier assembly revision levels, perform the changes indicated in Table 7A-1.

CHANGES

1. On Rev. C of the A3 Thermocouple Input Assy switch S1 is a 6-pin rotary switch, Fluke/Mfg. Part No. 429357 and Mfg. Supply Code 89536, in lieu of the 8-pin DIP switch module listed in the parts list.

2. On Rev. — of the A4 Output Option -002 switches S1, S2, and S3 are 6-pin rotary switches, Fluke/Mfg. Part No. 429357 and Mfg. Supply Code 89536, in lieu of the 8-pin DIP switch module listed in the parts list.

Ref Or Option No.	Assembly Name	Fluke Part No.	To adapt manual to earlier rev configurations perform changes in desending order (by no.), ending with change under desired rev letter																													
			–	A	B	C	D	E																									
A1	Main PCB Assembly	469395			X																											
A2	Display PCB Assembly	464479				X																										
A3	Digital Output Unit PCB Assembly	464461				1	X																									
A4 (–002)	Output Option	Option –002	2	X																												
A5 (–006)	Limits Option	Option –006						X																								

Section 8
Schematic Diagrams

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8-5.	A5 Limits Option (-006) PCB Assembly	2180A-1060	8-14
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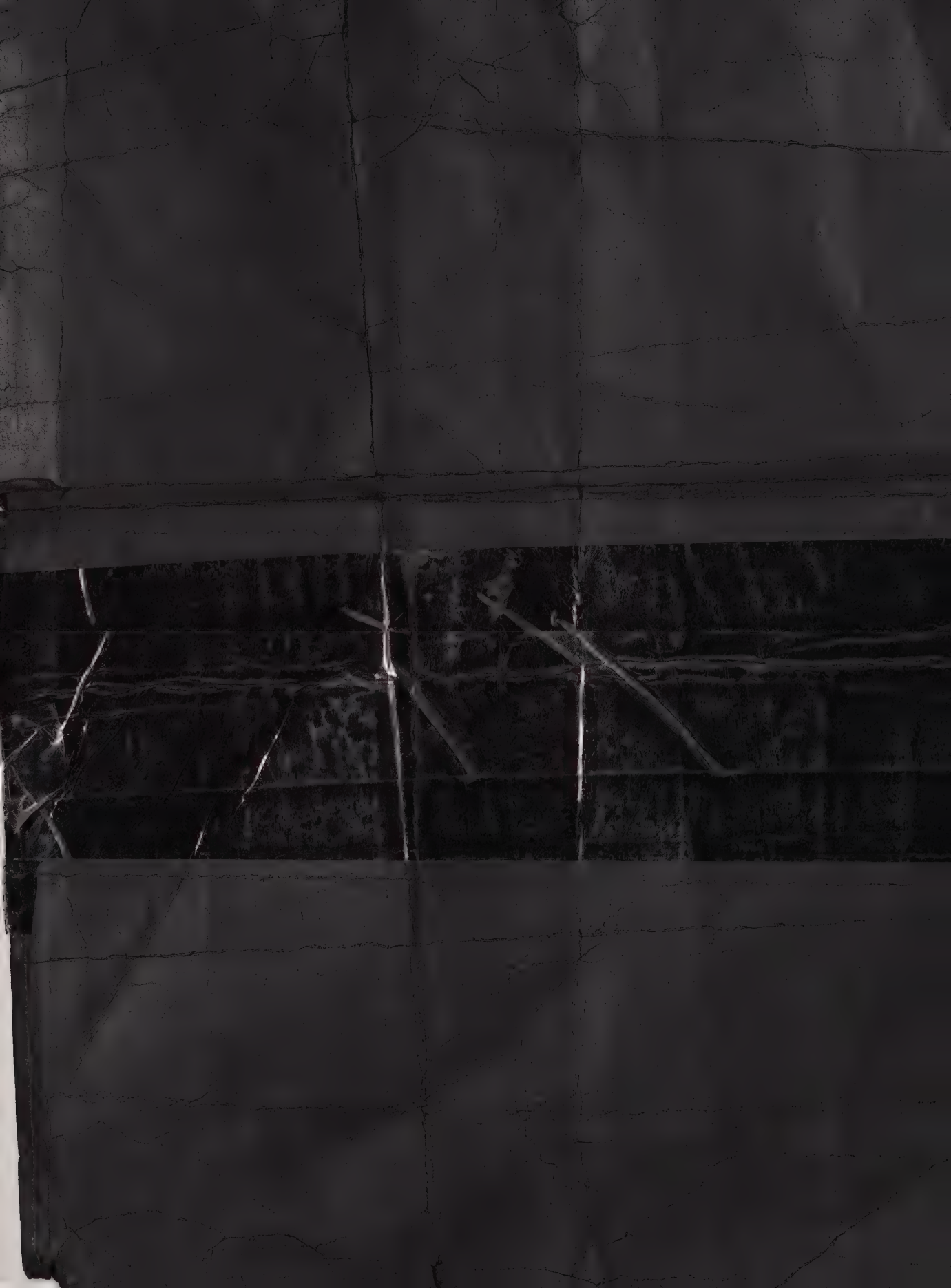


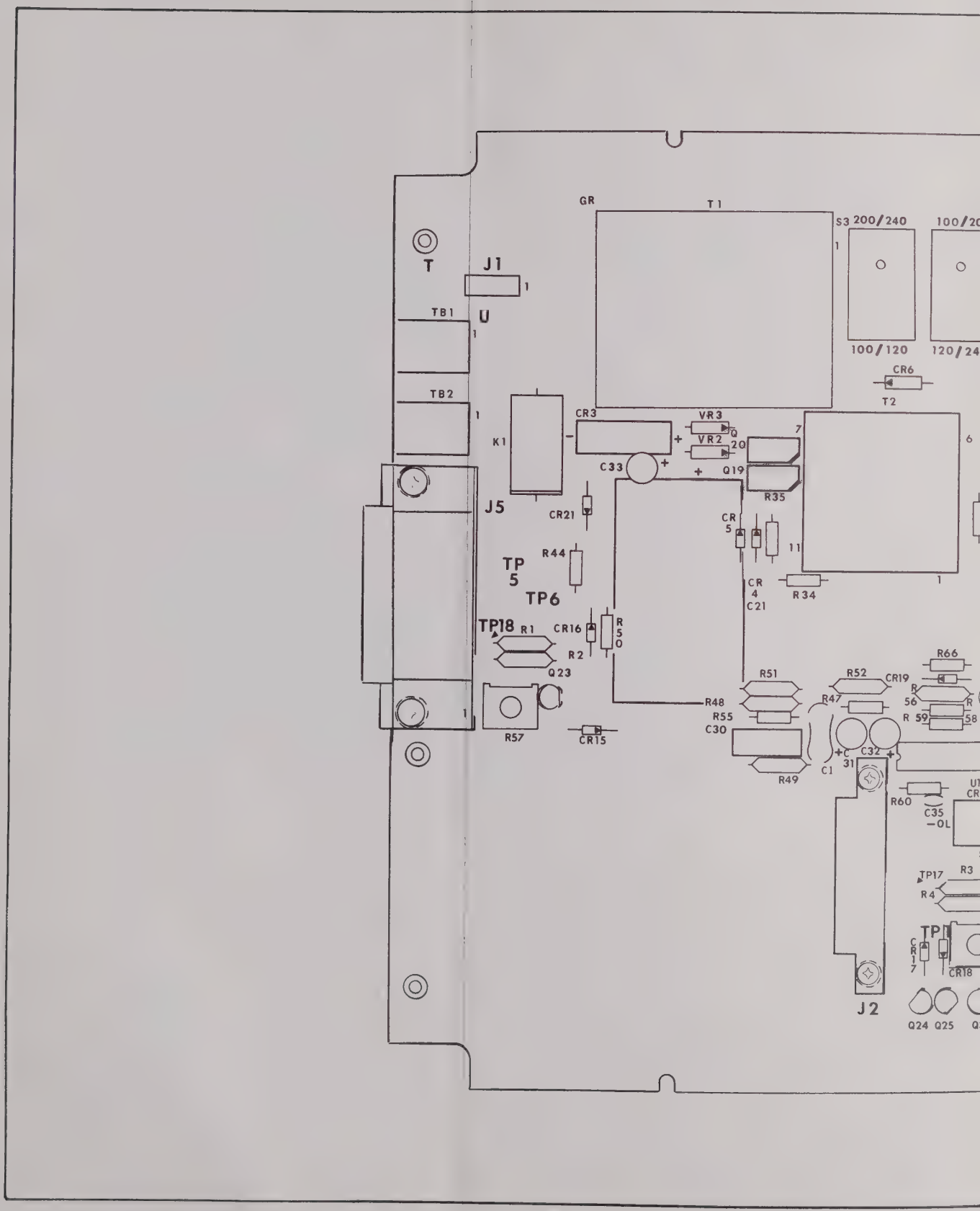
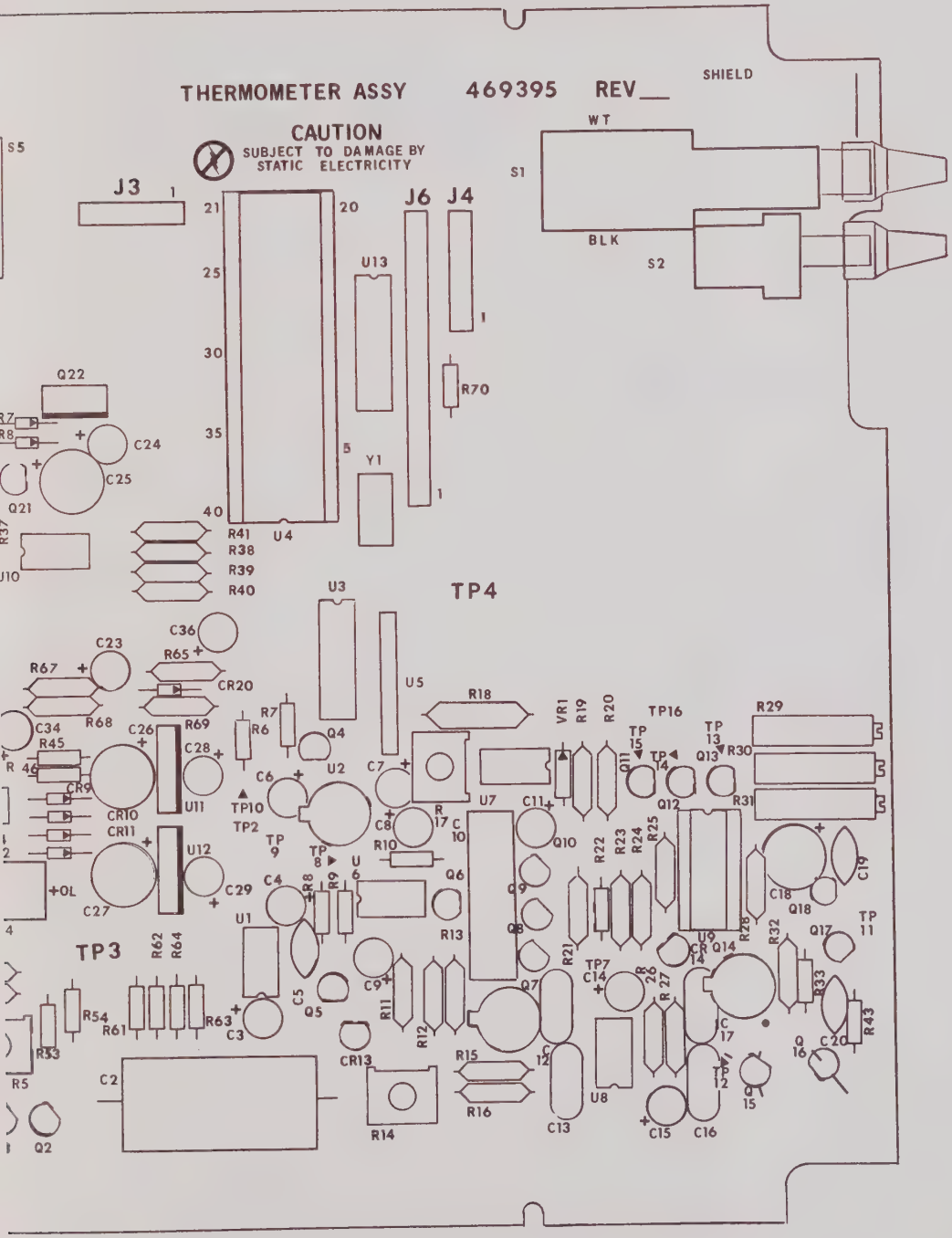
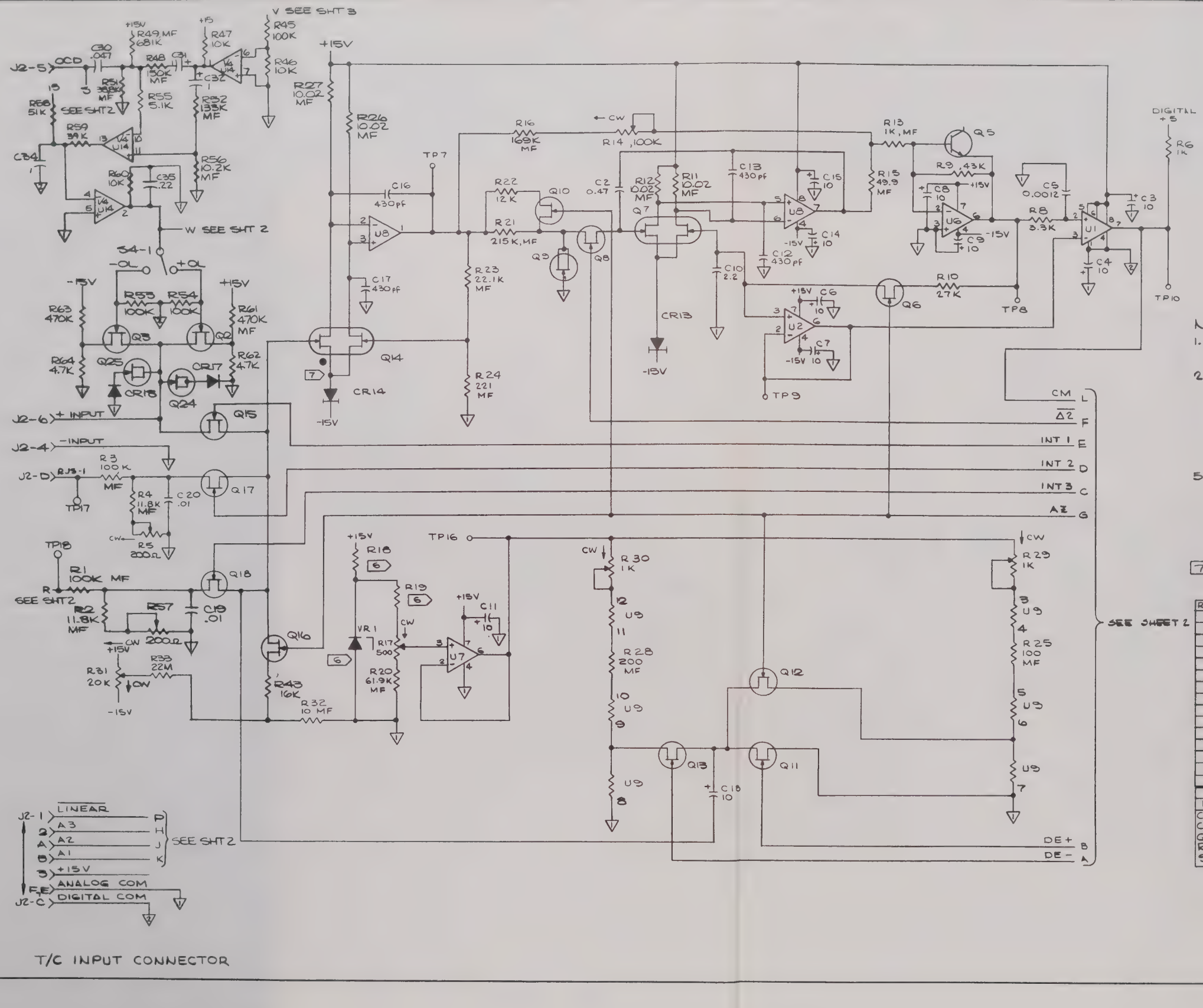


Figure 8-1. A1 Main PCB Assembly


THERMOMETER ASSY 469395 REV__
CAUTION
SUBJECT TO DAMAGE BY STATIC ELECTRICITY
SHIELD
WT
BLK
S1
S2
J3
J6
J4
U13
Y1
R70
U4
R41
R38
R39
R40
TP4
U3
U5
TP3
TP2
TP10
TP16
U2
U7
U1
U11
U12
U8
U9
Q22
Q21
C24
C25
C36
C23
C26
C28
C27
C29
C34
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
C17
C18
C19
C20
R67
R65
CR20
R68
R69
R45
R46
CR9
CR10
CR11
R7
R6
Q4
R18
VR1
R19
R20
TP15
TP14
TP13
Q11
Q13
R30
R29
R31
Q12
Q10
R22
R23
R24
R25
R10
Q6
Q9
Q8
R13
R21
R28
R32
Q17
Q18
Q14
CR14
TP11
TP7
R26
R27
R33
R43
C17
Q16
C20
R62
R64
R54
R61
R63
R53
R5
Q2
C5
Q5
R11
R12
CR13
R14
R15
R16
C13
U8
C15
C16
Q15
TP12
+OL

2190A-1601



NOTES:

1. UNLESS OTHERWISE SPECIFIED, ALL RESISTANCE IS IN OHMS AND ALL CAPACITANCE IS IN MICROFARADS.
2. ALL RESISTORS ARE 1/4W, 5% UNLESS OTHERWISE SPECIFIED.

5. ▽ DENOTES ANALOG COMMON (0 VOLTS)
   ▽ DENOTES DIGITAL COMMON. DIGITAL COMMON IS -15V WITH RESPECT TO ANALOG COMMON
   /// DENOTES EARTH COMMON
   WARNING: DO NOT CONNECT ▽ TO ▽ DAMAGE MAY RESULT.

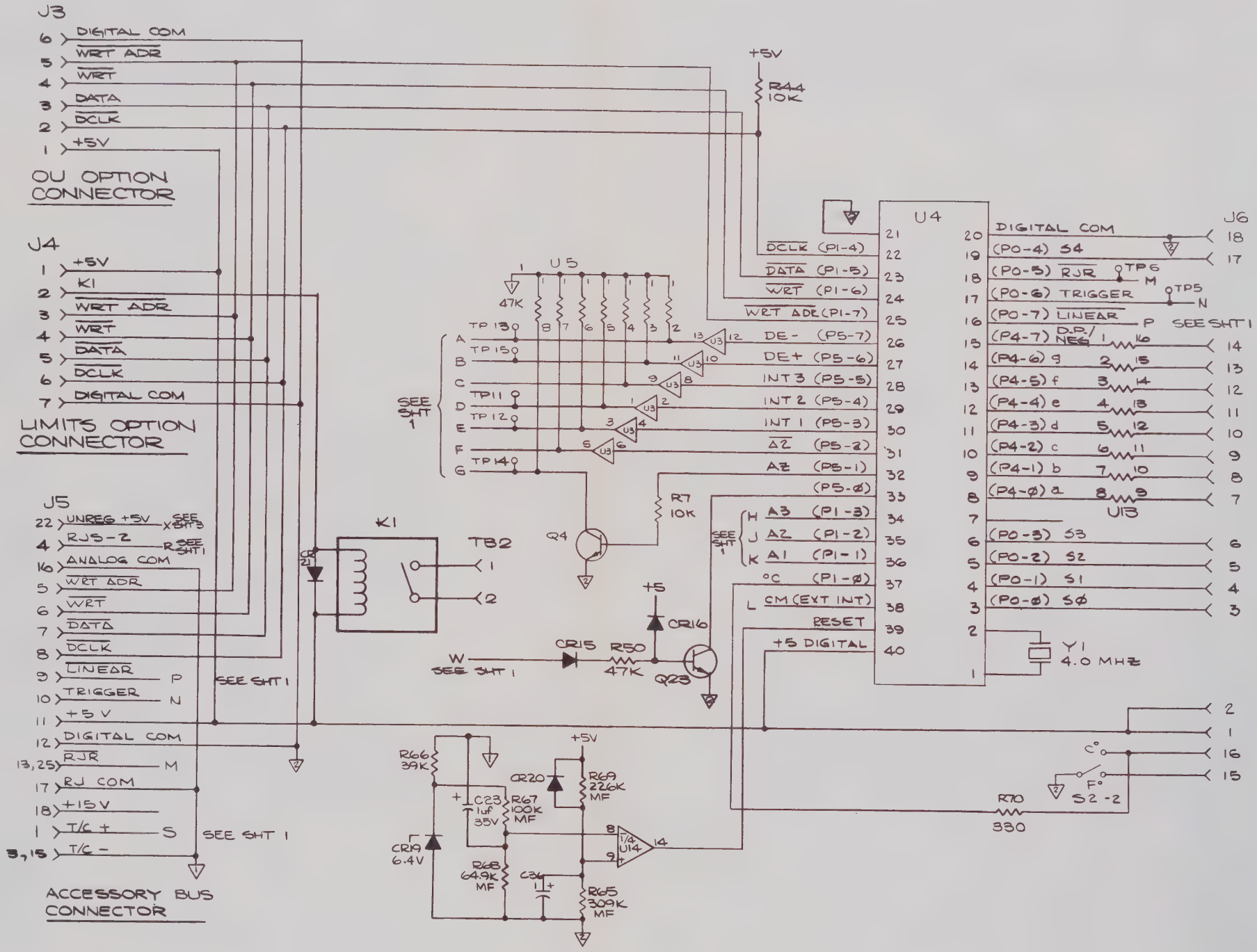
7. LOCATE WITH MARKED GATE IN POSITION SHOWN

REF DES	+5 DIG	+15 V	▽	▽
U1		5,6,8	1,4	
U2		7	4	
U3	14		7	
U4	40		20,21	
U5				
U6		7		4
U7		7		4
U8		8	4	
U9				7,8
U10			4	5,6
U11				
U12				
U13				
U14		3	12	

REFERENCE DESIGNATION	
LAST USED	NOT USED
C36 T2 CR21 U14 Q25 VR3 R70 S5	C1 CR1, CR2 Q1 R36, R42

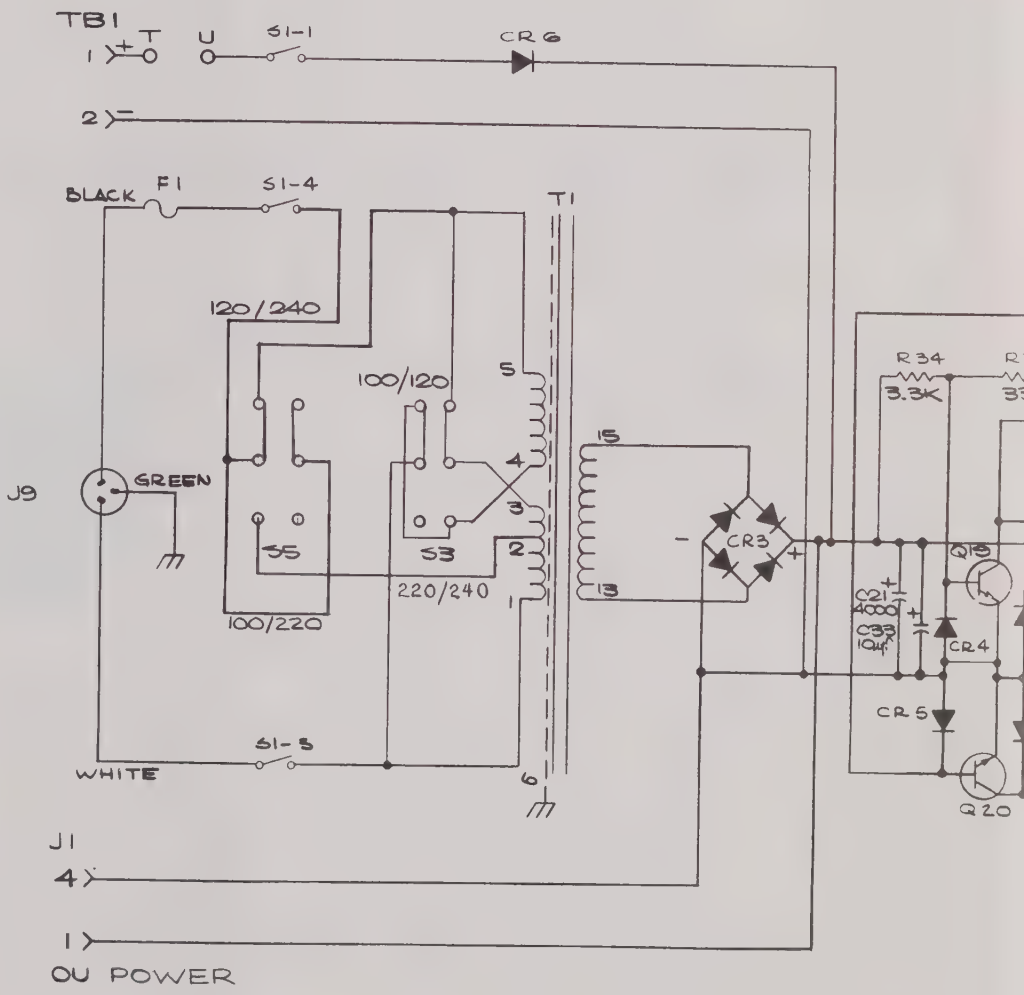
2190A-1001
(Sheet 1 of 3)

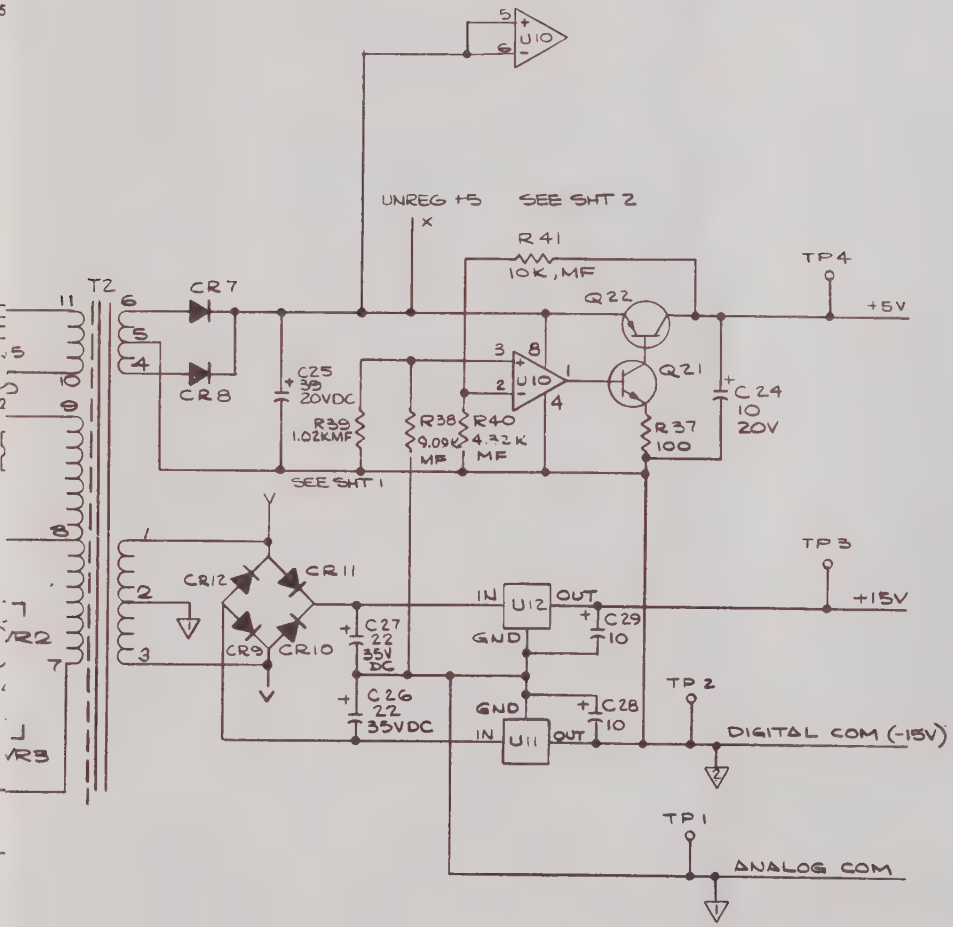
Figure 8-1. A1 Main PCB Assembly (cont)



2190A-1001
(Sheet 2 of 3)

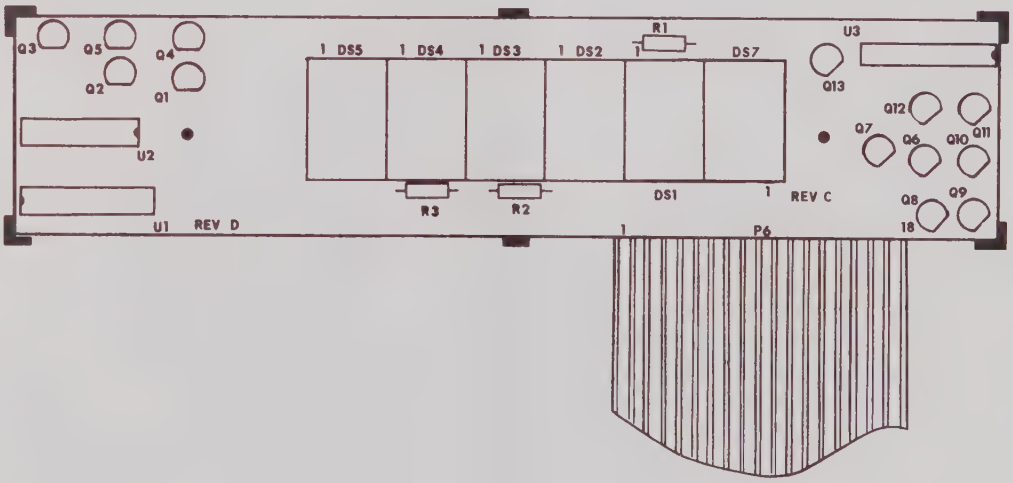
Figure 8-1. A1 Main PCB Assembly (cont)


TB1
1
T
U
S1-1
CR6
2
BLACK
F1
S1-4
T1
120/240
100/120
5
4
3
2
1
15
13
6
J9
GREEN
S5
S3
220/240
100/220
CR3
R34
3.3K
C21
4000
C33
10μf
CR4
CR5
Q20
S1-5
WHITE
J1
4
1
OU POWER



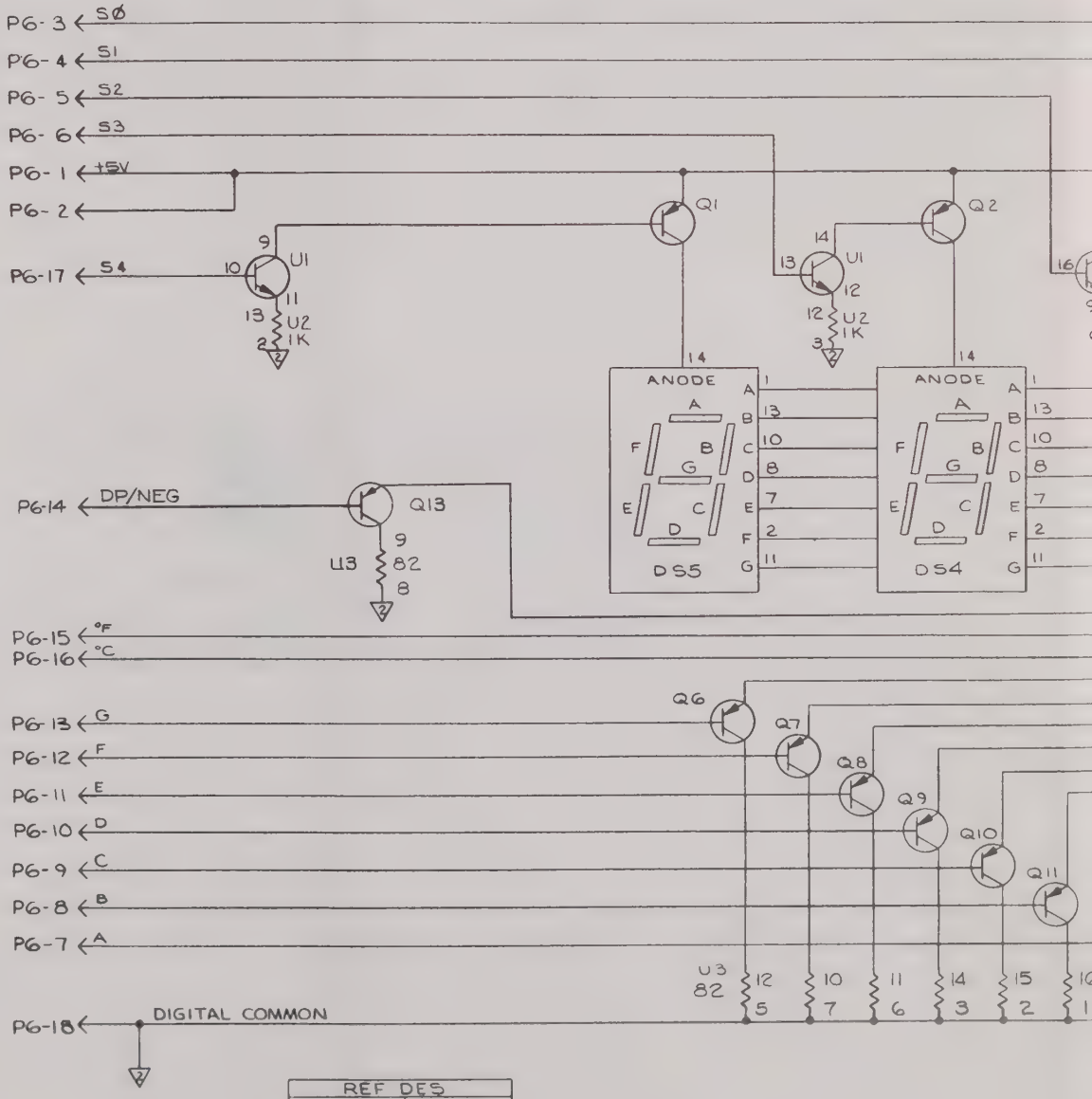
2190A-1001
(Sheet 3 of 3)

Figure 8-1. A1 Main PCB Assembly (cont)

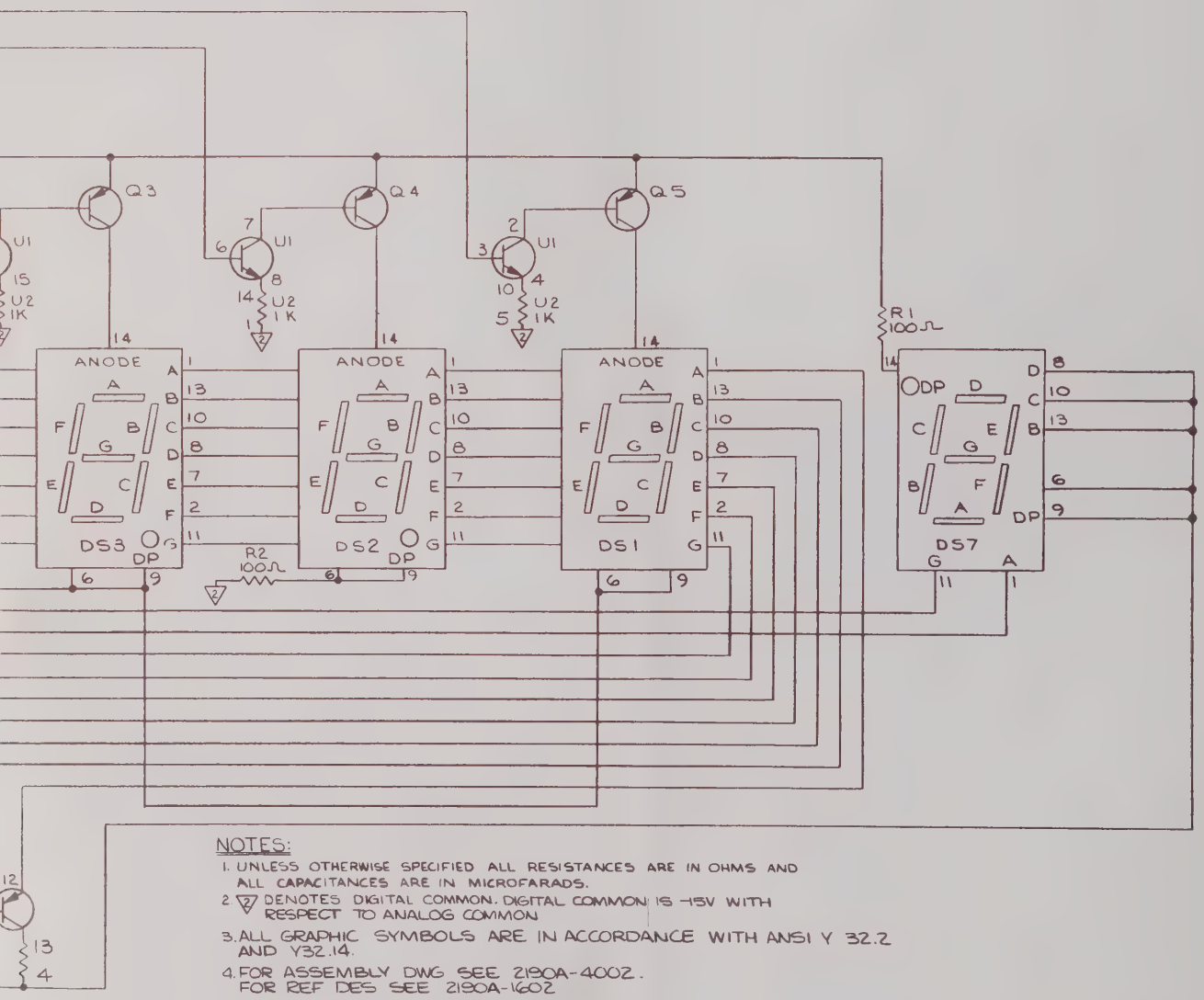


2190A-1602

Figure 8-2. A2 Display PCB Assembly



REF DES	
LAST USED	NOT USED
R2, Q13, U3 DS1-5 & 7	DS6.

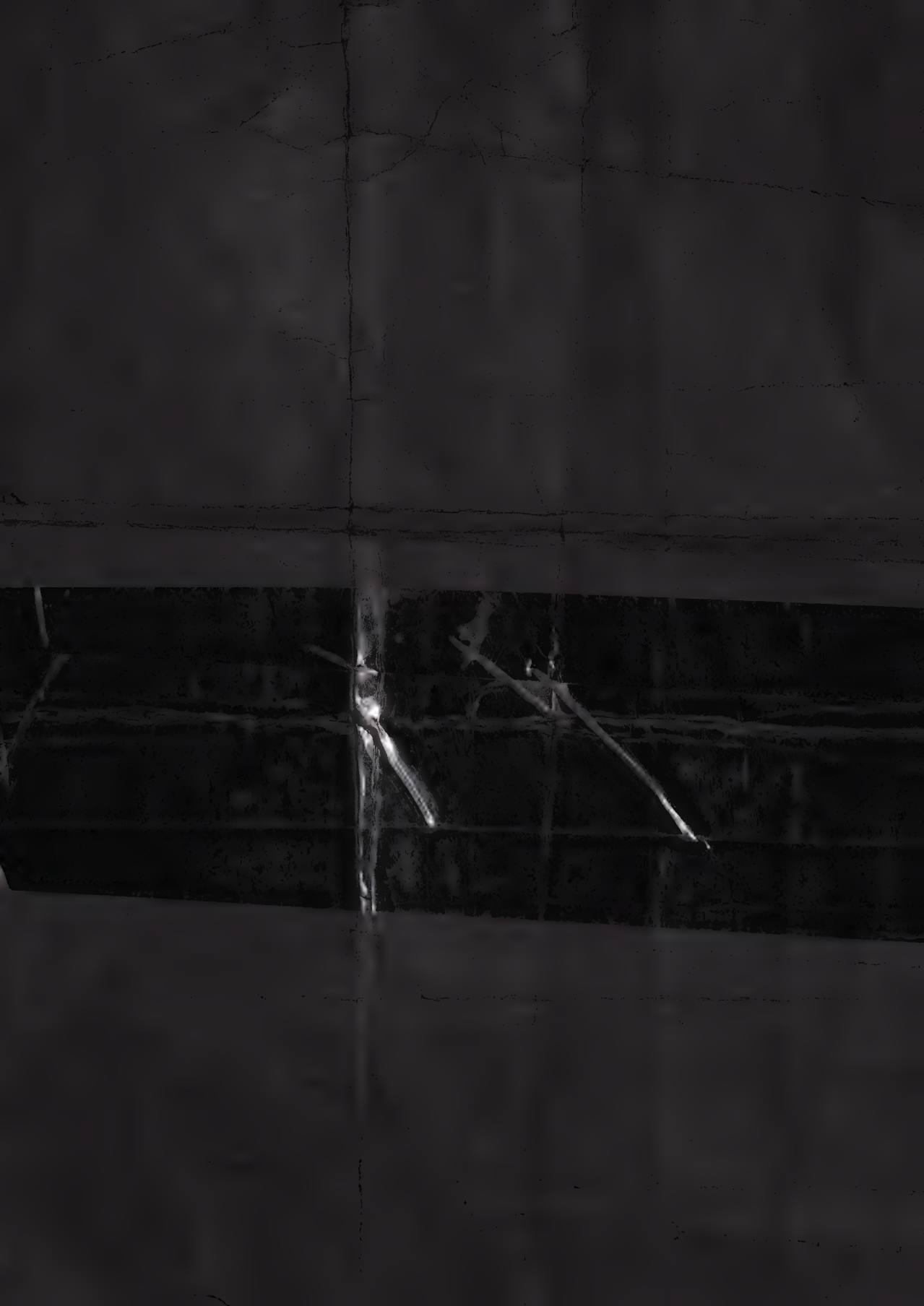


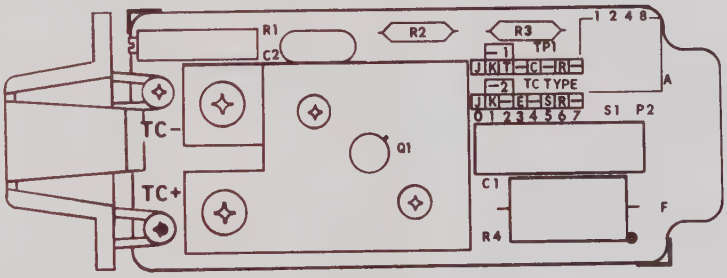
NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCES ARE IN MICROFARADS.
2. ▽2 DENOTES DIGITAL COMMON. DIGITAL COMMON IS +15V WITH RESPECT TO ANALOG COMMON
3. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y 32.2 AND Y32.14.
4. FOR ASSEMBLY DWG SEE 2190A-4002. FOR REF DES SEE 2190A-1602
5. ALL RESISTORS 1/4W, 5%, UNLESS OTHERWISE SPECIFIED

2190A-1002

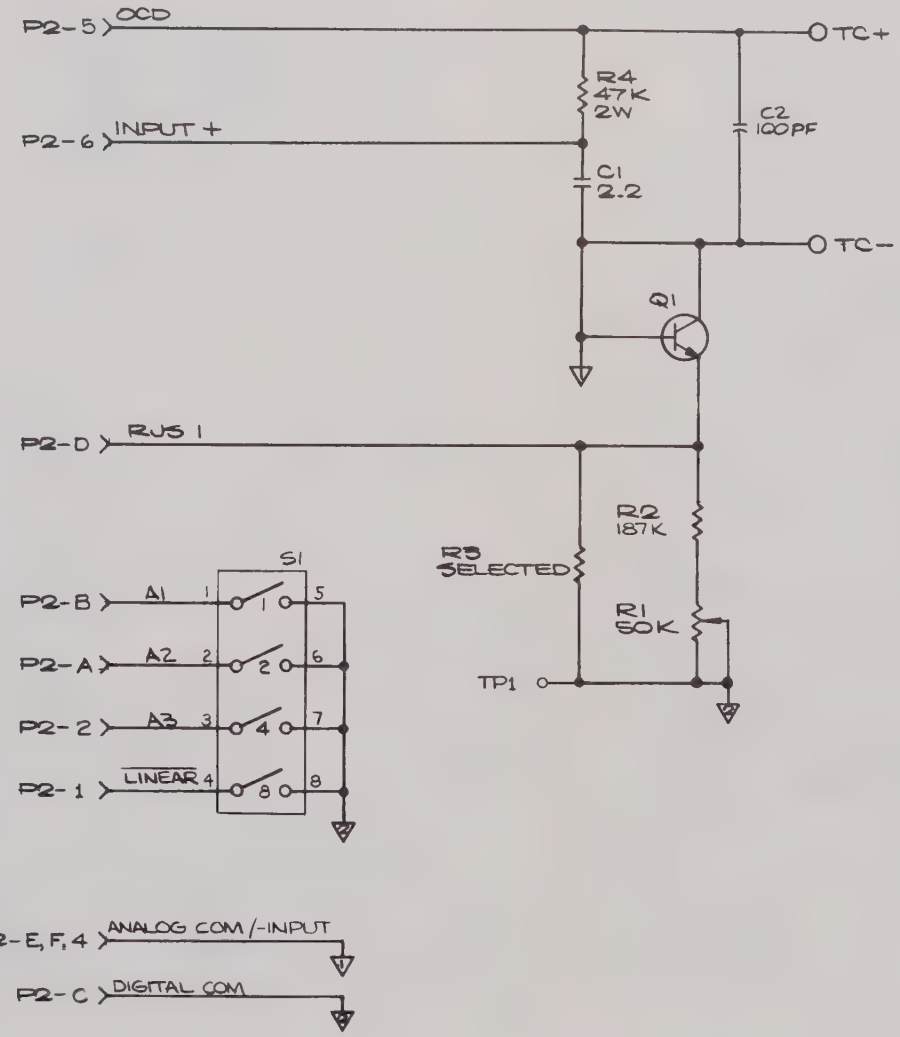
Figure 8-2. A2 Display PCB Assembly (cont)





2190A-1603

Figure 8-3. A3 Thermocouple Input PCB Assembly

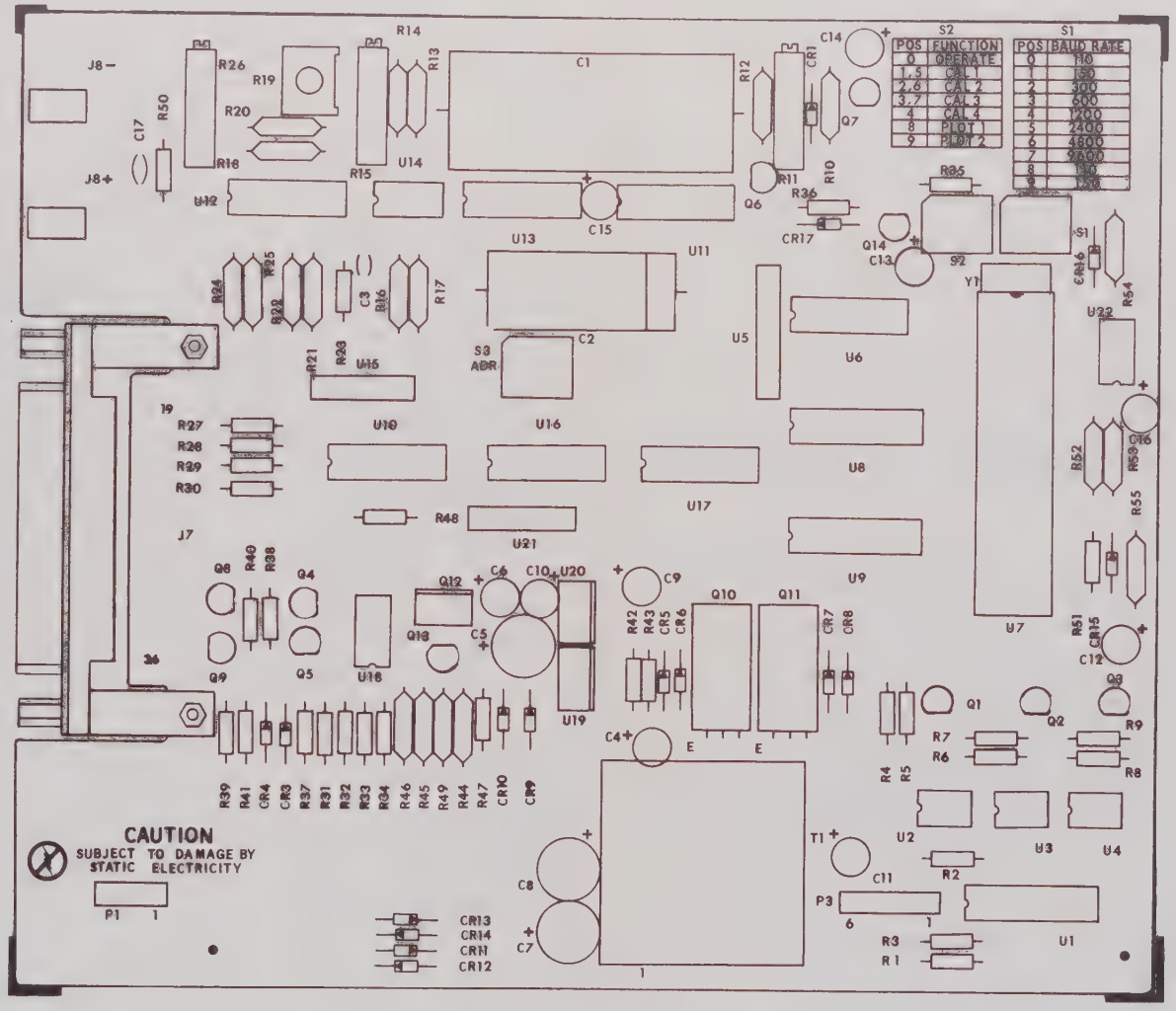


NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCES ARE IN MICROFARADS.
2. ALL RESISTORS ARE ¼W, 5% UNLESS OTHERWISE NOTED.
3. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 AND Y32.14.
4. ▽ DENOTES ANALOG COMMON
   ▼ DENOTES DIGITAL COMMON. DIGITAL COMMON IS -15V WITH RESPECT TO ANALOG COMMON
5. FOR ASSY DWG SEE 2190A-4003
   FOR REF DES DWG SEE 2190A-1603

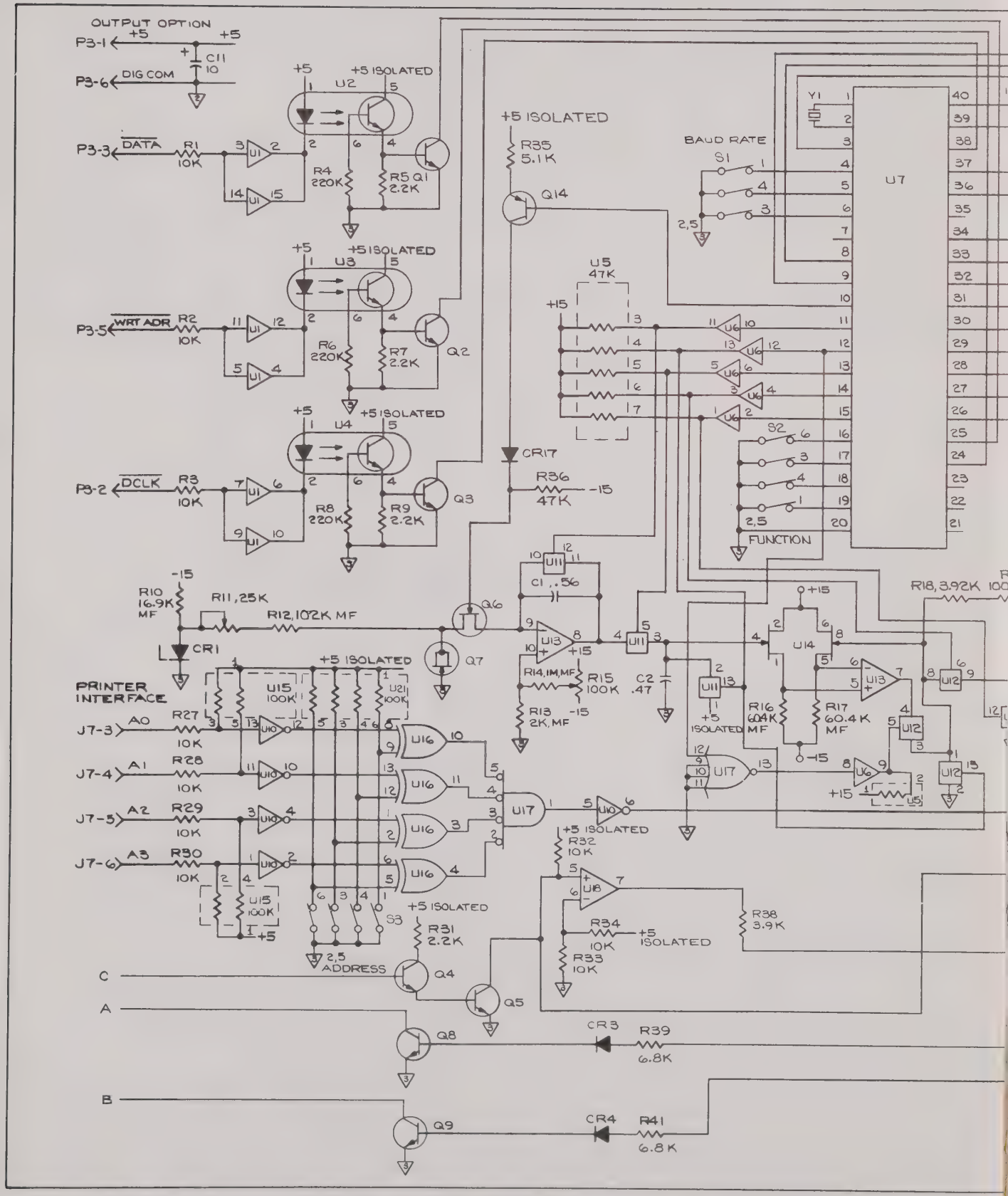
2190A-1003

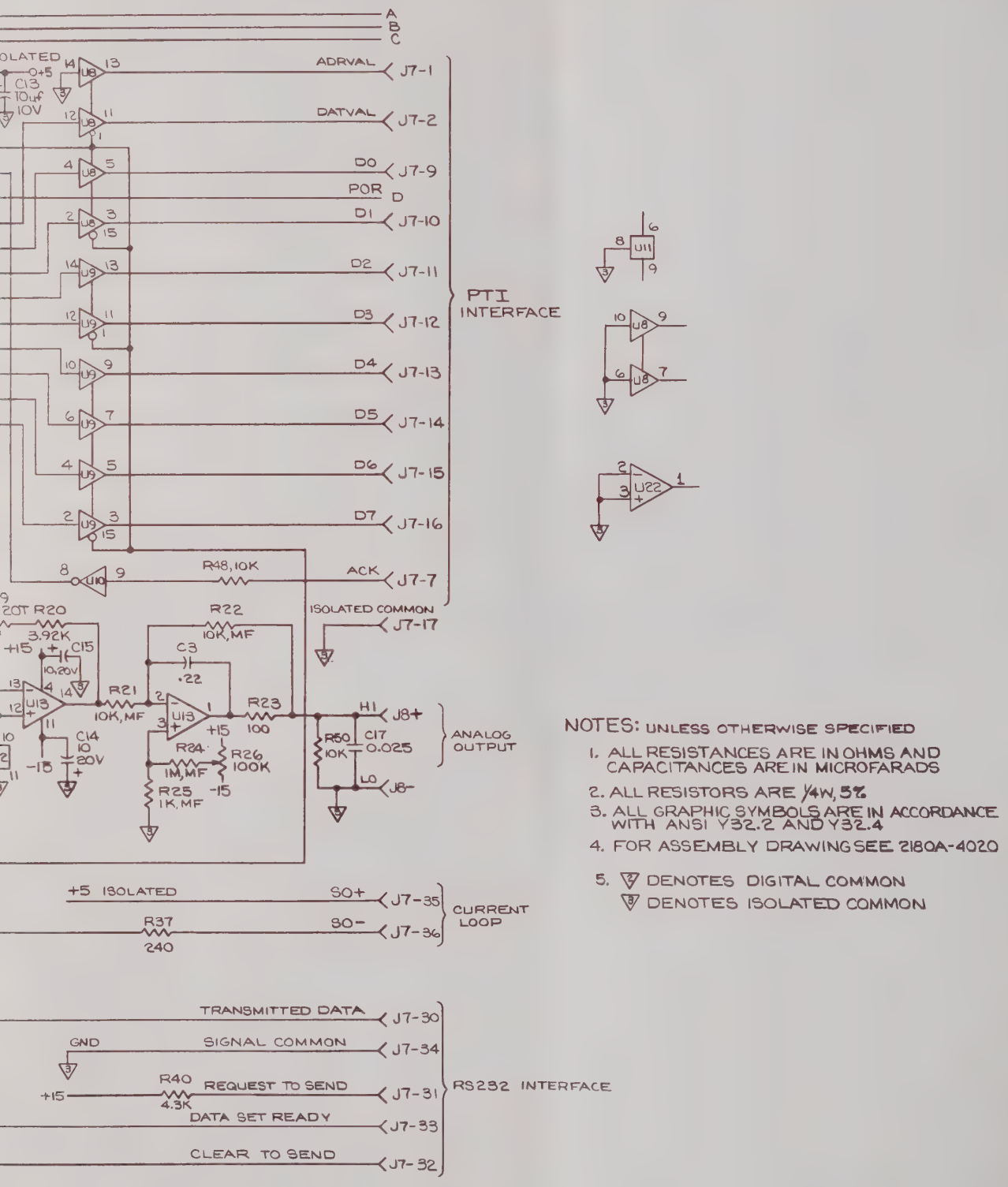
Figure 8-3. A3 Thermocouple Input PCB Assembly (cont)



2180–1620

Figure 8-4. –002 Output Option PCB Assembly


OUTPUT OPTION
P3-1
+5
C11
10
P3-6
DIG COM
+5 ISOLATED
U2
P3-3
DATA
R1
10K
R4
220K
R5 Q1
2.2K
U3
P3-5
WRT ADR
R2
10K
R6
220K
R7
2.2K
Q2
U4
P3-2
DCLK
R3
10K
R8
220K
R9
2.2K
Q3
R35
5.1K
Q14
CR17
R36
47K
-15
BAUD RATE
S1
2,5
Y1
U7
U5
47K
+15
S2
FUNCTION
C1 .56
R10
16.9K
MF
R11 ,25K
R12,102K MF
CR1
Q6
Q7
U13
R14,1M,MF
R15
100K
C2
.47
R13
2K,MF
U14
R16
604K
MF
R17
60.4K
MF
R18,3.92K
PRINTER
INTERFACE
U15
100K
U21
100K
J7-3
A0
R27
10K
J7-4
A1
R28
10K
J7-5
A2
R29
10K
J7-6
A3
R30
10K
U16
U17
S3
2,5
ADDRESS
R31
2.2K
Q4
Q5
R32
10K
U18
R34
10K
R33
10K
R38
3.9K
C
A
B
Q8
Q9
CR3
CR4
R39
6.8K
R41
6.8K

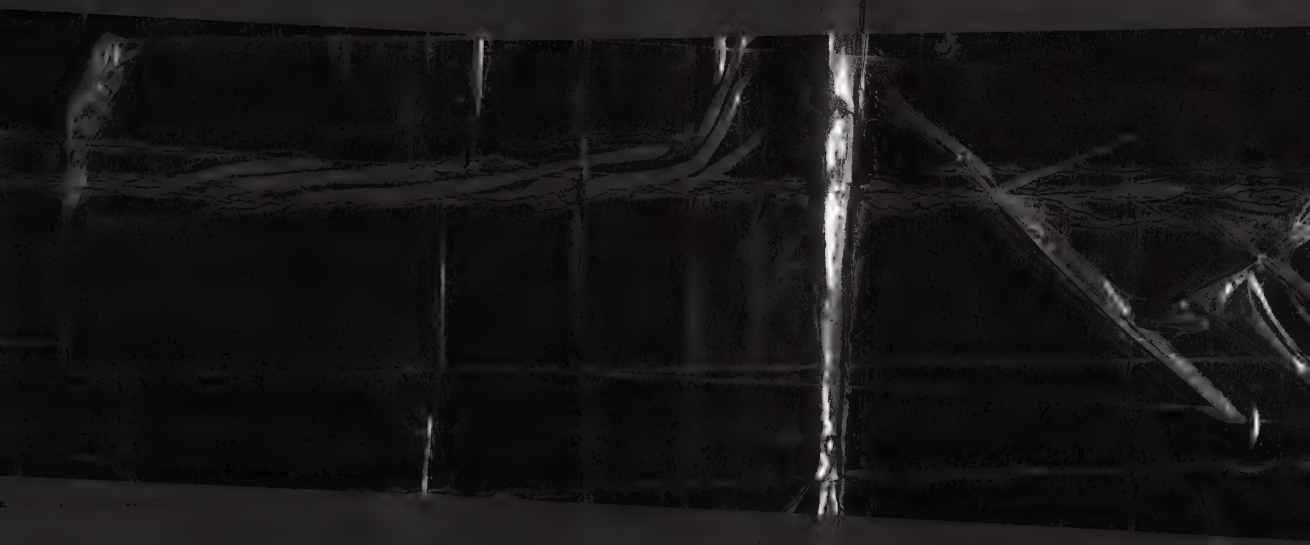


NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTANCES ARE IN OHMS AND CAPACITANCES ARE IN MICROFARADS
2. ALL RESISTORS ARE ¼W, 5%
3. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 AND Y32.4
4. FOR ASSEMBLY DRAWING SEE 2180A-4020
5. ▽ DENOTES DIGITAL COMMON
   ▽ DENOTES ISOLATED COMMON

2180-1020
(Sheet 1 of 2)

Figure 8-4. –002 Output Option PCB Assembly (cont)



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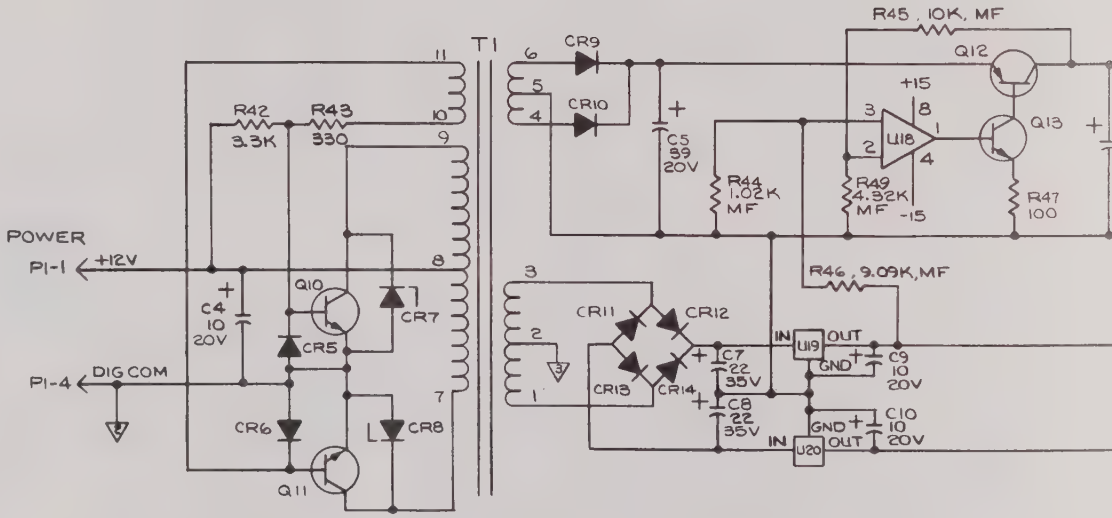
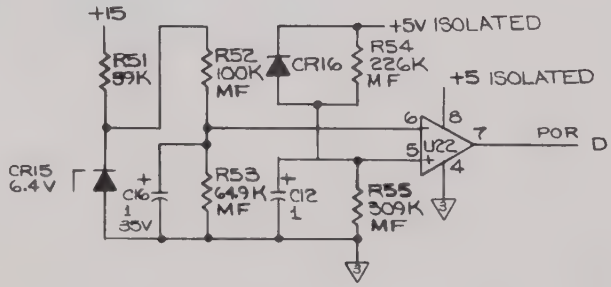




REF DESIGNATIONS	
LAST USED	NOT USED
C17	
CR17	CR2
U22	
R55	
Q14	
S3	
T1	

+5 ISOLATED

COMMON ISOLATED

+15

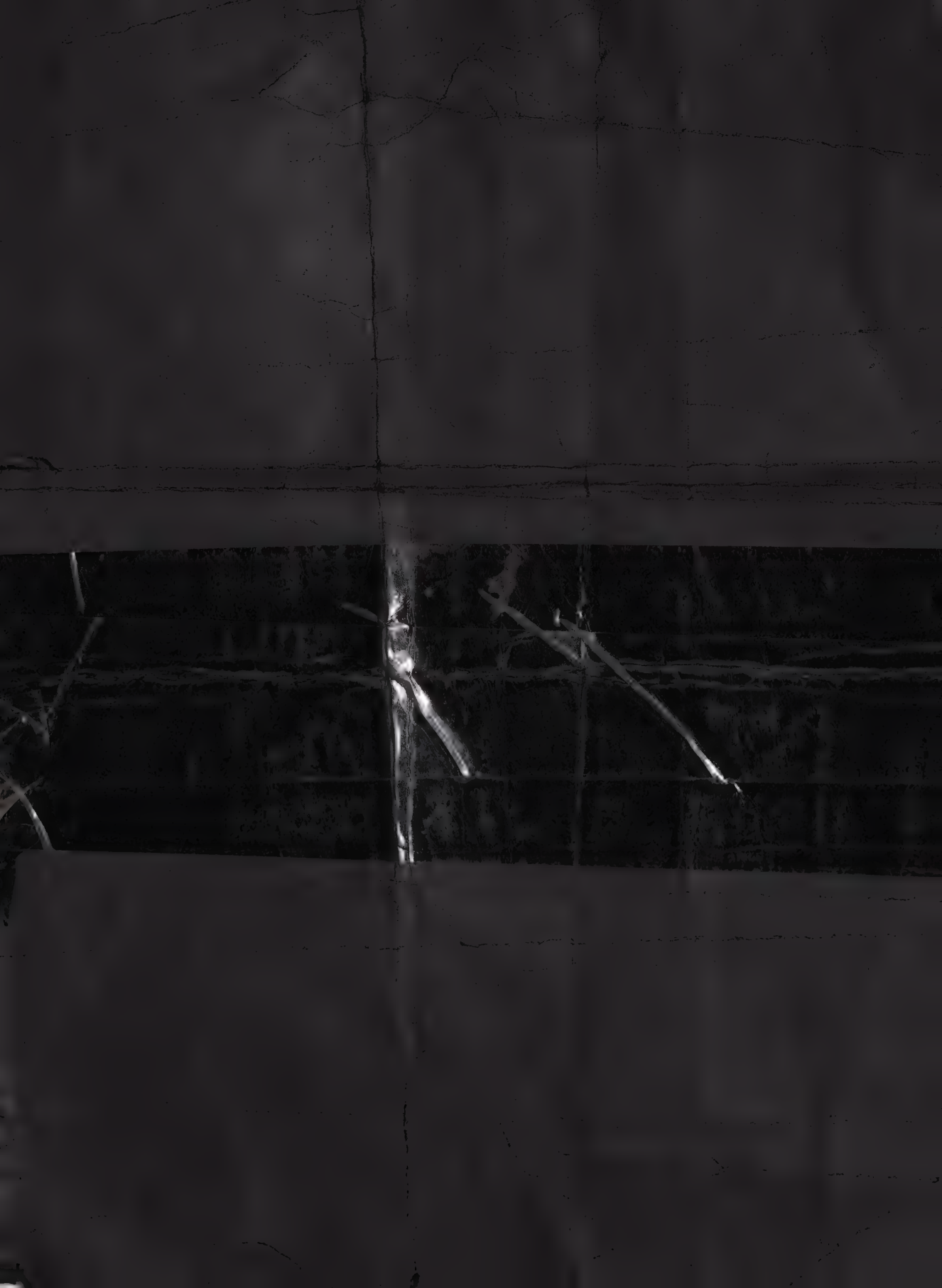
-15

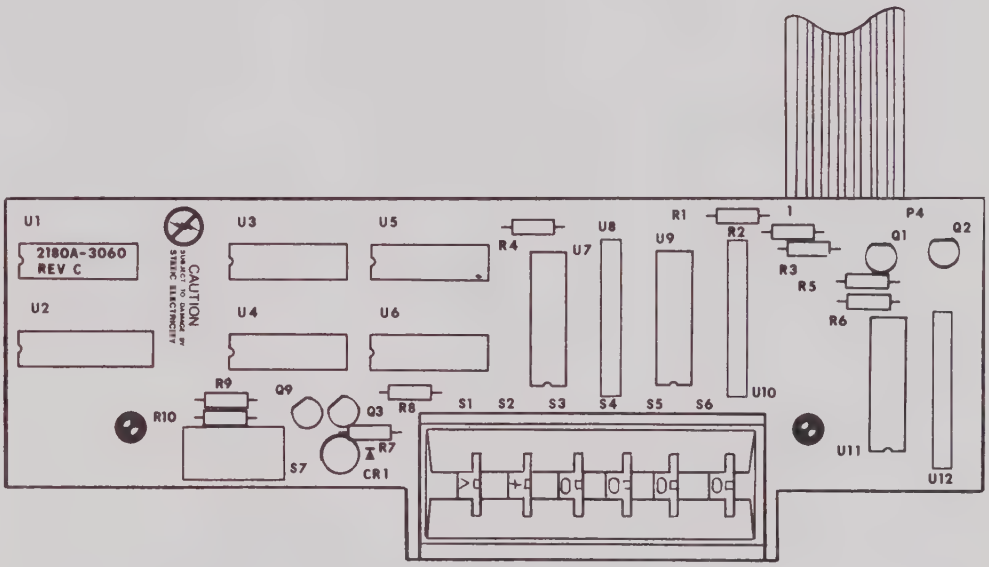
DES	+5	GND	+5 ISOLATED	+15	-15	GND ISOLATED
U1	1	8				
U2	1		5			
U3	1		5			
U4	1		5			
U5				1		
U6			14			7
U7			40			20
U8			16			8
U9			16			8
U10			14			7
U11				14		7
U12				14		7
U13				4	11	
U14				2&6		
U15,U21			1			
U16			14			7
U17			14			7
U18				8	4	

DES	+5	GND	+5 ISOLATED	+15	-15	GND ISOLATED
U22		4	8			

2180A–1020
(Sheet 2 of 2)

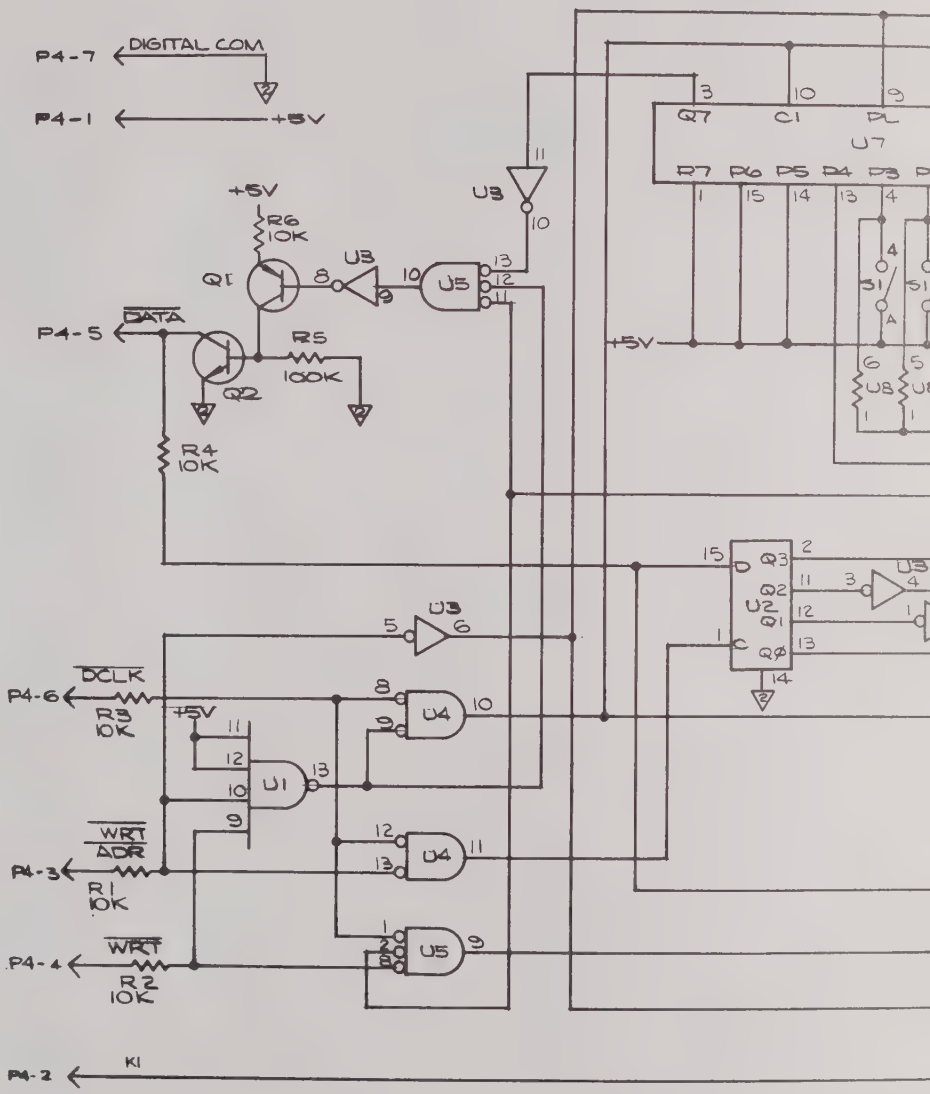
Figure 8-4. –002 Output Option PCB Assembly (cont)





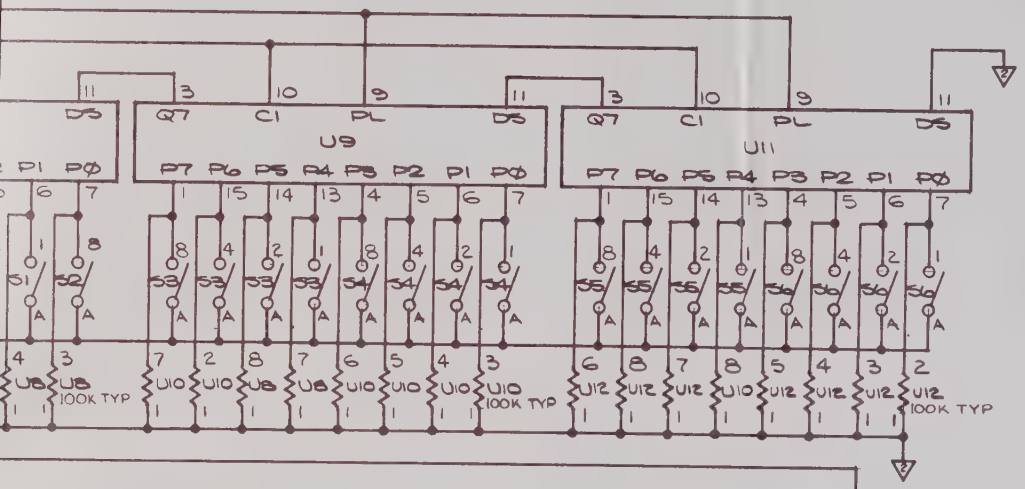
2180A-1660

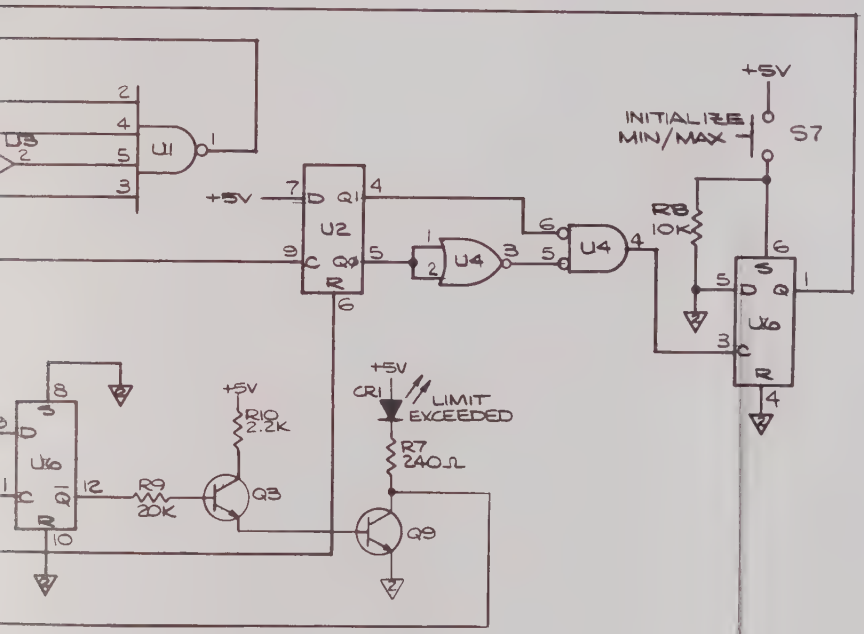
Figure 8-5. –006 Limits Option PCB Assembly

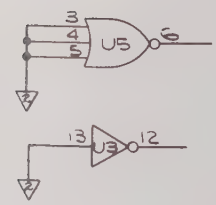


NOTES:

1. UNLESS OTHERWISE SPECIFIED ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCES ARE IN MICROFARADS.
2. ALL RESISTORS ARE 1/4W, 5% UNLESS OTHERWISE NOTED.
3. ALL GRAPHIC SYMBOLS ARE IN ACCORDANCE WITH ANSI Y32.2 & Y32.14.
4. FOR ASSY DRAWING SEE 2180A-4060.
5. FOR REF. DES. DRAWING SEE 2180A-16660.
6. ▽ DENOTES DIGITAL COMMON. DIGITAL COMMON IS -15V WITH RESPECT TO ANALOG COMMON







I.C.	+5V	⏚
U1	14	7
U2	16	8
U3	14	7
U4	14	7
U5	14	7
U6	14	7
U7	16	8
U9	16	8
U11	16	8

REF DES	
LAST USED	NOT USED
U12,R8,S7,Q9	Q4,Q5,Q6,Q7,8

2180A-1060

Figure 8-5. –006 Limits Option PCB Assembly (cont)

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